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Canotia is named for *Canotia holacantha* Torr. (Celastraceae), a spiny shrub or small tree nearly endemic to Arizona.

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BOTANICAL
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SOLANACEAE POTATO FAMILY

PART TWO: KEY TO THE GENERA AND SOLANUM L.

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Annual and perennial herbs or shrubs (sometimes trees or vines elsewhere); unarmed or armed, the surfaces glabrous to variously hairy. LEAVES simple to variously compound, alternate, sub-opposite or fascicled. INFLORESCENCES uniflorous, panicles, umbels, racemes, or complex cymes. FLOWERS pedicellate, ebracteate, 4–5(–6)-merous, actinomorphic to zygomorphic; calyx synsepalous, deeply lobed to unlobed; corolla sympetalous; stamens usually the same number as corolla lobes, the filaments adnate to corolla tube between lobes, the anthers free, adherent, or connivent, basifixed or dorsifixed, ovate to lanceolate-linear, opening longitudinally or by terminal slits or pores; perigynous nectary often present; pistil syncarpous, usually bicarpellate and bilocular; stigma capitate to bilobed; style 1, terminal; ovary superior, usually bicarpellate and bilocular, the placentation axile, the ovules numerous, campylotropous. FRUITS capsules or berries; seeds many, mostly wingless and reniform-flattened, less often winged and prismatic. —Ca. 90 genera and 3000–4000 spp. worldwide, especially in C. and S. Amer. (Nee 2004).

1. Fruit a spiny capsule; flower (3.8–)5–26 cm long ..... ***Datura***
1' Fruit a berry or capsule without spines; flowers 0.5–7 cm long 2
  2. Woody shrubs or trees 3
    3. Flowers to 3–4.5 cm long; fruits capsules; petioles > 1.5 cm long; leaves 4–17 cm long ..... ***Nicotiana glauca***
    3' Flowers 0.5–2.5 cm long; fruits berries; petioles < 1.5 cm long; leaves 1–5 cm long 4
      4. Twigs often ending in thorns; flowers normally solitary in leaf axils; corolla white, greenish, to purple, rarely over 15 mm wide; anthers longitudinally dehiscent ..... ***Lycium***
      4' Twigs unarmed; flowers normally in umbels or racemes; corolla deep blue to lavender; 15–30 mm wide; anthers terminally dehiscent ..... ***Solanum xanti***
  2' Herbaceous or suffrutescent herbs 5
    5. Corolla salverform, funnelform, or urceolate (mostly longer than wide) 6
      6. Corolla notably zygomorphic; stamens 4 ..... ***Browallia***
      6' Corolla actinomorphic or nearly so; stamens 5 7
        7. Corolla urceolate 8
          8. Calyx inflated in fruit; corolla purple ..... ***Margaranthus***
          8' Calyx not inflated in fruit; corolla greenish to cream-white ... ***Salpichroa***

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E. Makings, E. Manton, D. Newton, and L.R. Landrum.

7' Corolla salverform to funnelform 9
9. Leaves > 2 cm wide; flowers > 1.5 cm long; generally erect ... ***Nicotiana***
9' Leaves < 2 cm wide; flowers < 1 cm long; generally decumbent .....
..... ***Calibrachoa***
5' Corolla rotate to broadly campanulate (mostly wider than long) 10
10. Calyx inflated in fruit, covering entire fruit, similar in appearance to a 'Chinese lantern' 11
11. Corolla yellow to cream-colored ..... ***Physalis***
11' Corolla purple ..... ***Quincula***
10' Calyx sometimes accrescent, but not inflated in fruit 12
12. Fruits capsules ..... ***Browallia***
12' Fruits berries 13
13. Stamens dehiscing by short, terminal slits or pores ..... ***Solanum***
13' Stamens dehiscing longitudinally 14
14. Leaves compound; anthers connivent ..... ***Solanum lycopersicum***
14' Leaves simple; anthers free 15
15. Calyx lobes about as long as tube; leaves mostly > 3 cm wide; inflorescence umbel-like, with 5 or more flowers ..... ***Jaltomata***
15' Calyx lobes much shorter than tube; leaves < 2.5 cm wide; inflorescence simple, with 1–2 flowers 16
16. Leaves ovate-lanceolate, mostly 1 cm or more wide; corolla without tomentose pads on inner surface ..... ***Capsicum***
16' Leaves narrowly linear to elliptic, less than 0.5 cm wide; corolla with tomentose pads on inner surface alternating with stamens ..... ***Chamaesaracha***

Solanum L. Nightshade

Annual or perennial herbs and shrubs in ours, some armed with prickles, the surfaces often hairy, the hairs simple, branched, or stellate, sometimes glandular. LEAVES petiolate, simple, to pinnately compound, the margins entire, dentate to deeply lobed. INFLORESCENCES mostly borne between nodes, often lateral (opposite a leaf on stem), uniflorous to complex cymes. FLOWERS (4–)5-merous, actinomorphic to zygomorphic; calyx sometimes accrescent in fruit; corolla rotate to broadly campanulate; stamens sometimes unequal; anthers basifixed, oblong to lanceolate-linear, opening by terminal slits or pores; filaments shorter than anthers; stigma capitate. FRUITS berries, remaining fleshy or becoming dry; seeds wingless, lenticular to flattened-reniform. —18 spp. in AZ, ca. 1400 spp. worldwide, especially in S. Amer. (Bohs 2001).

Known as "the deadly nightshades" due to high concentrations of alkaloids in the vegetative and reproductive structures of some species. The genus contains important agricultural crops such as tomato (*S. lycopersicum*), potato (*S. tuberosum*), eggplant (*S. melongena*), and many regionally cultivated species. *Solanum* has also been used medicinally worldwide, for example, in the American Southwest a preparation of *S. elaeagnifolium* was used in treating ear, nose, and throat ailments, as well as eye infections and toothaches (Rea 1997).

1. Plants armed with prickles 2
  2. Leaves unlobed or shallowly lobed 3
    3. Larger leaves wider than 3.5 cm, the margins lobed; seeds reddish brown ..... ***S. carolinense***
    3' Larger leaves not wider than 3.5 cm, the margins repand-undulate; seeds tan to brownish black 4
      4. Shrubs to 2.5 m tall; prickles stout, from a thickened base; fruits erect; known only from Organ Pipe Cactus National Monument (Pima County) ..... ***S. hindsianum***
      4' Rhizomatous herbs to 1 m tall; prickles thin and delicate; fruit pendulous; distributed throughout the state ..... ***S. elaeagnifolium***
  2' Leaves variously pinnatifid to pinnatisect 5
    5. Cauline hairs non-glandular, mostly stellate; corolla yellow ..... ***S. rostratum***
    5' Cauline hairs glandular, mostly simple; corolla violet to blue or yellow 6
      6. Leaves with rounded ultimate lobes; corolla violet to blue; anthers of two sizes; seeds minutely pitted ..... ***S. heterodoxum***
      6' Leaves with acute ultimate lobes; corolla yellow; anthers of three sizes; seeds radially ridged ..... ***S. lumholtzianum***
1' Plants unarmed, without prickles 7
  7. Leaves compound 8
    8. Anthers adherent; corolla yellow (drying white); leaflets toothed or lobed; fruit mostly greater than 1.5 cm in diameter, yellow-green to red at maturity; herbage glandular-pubescent ..... ***S. lycopersicum***
    8' Anthers free; corolla white to purple; leaflets entire; fruit mostly less than 1.5 cm in diameter, green at maturity; herbage glabrous to densely hairy with occasional glandular hairs 9
      9. Corolla usually white, 2.8–3.5 cm in diameter; leaflets usually 2–3 times longer than wide; herbage glabrous to sparsely pilose ..... ***S. jamesii***
      9' Corolla usually purple or rarely white tinged with purple, around 1.8–3.3 cm in diameter; leaflets usually less than 2 times longer than wide; herbage sparsely to copiously pilose ..... ***S. stoloniferum***
  7' Leaves simple (sometimes lobed) 10
    10. Herbage with stellate hairs; leaves coriaceous, the underside densely pubescent 11
      11. Shrubs to 2.5 m tall; fruit erect; known only from Organ Pipe Cactus National Monument (Pima County) ..... ***S. hindsianum***
      11' Rhizomatous herbs to 1 m tall; fruit pendulous; distributed throughout the state ..... ***S. elaeagnifolium***
    10' Herbage lacking stellate hairs; leaves subcoriaceous to membranaceous, the underside glabrous to hirsute, or densely villous 12
      12. Corolla deep blue to lavender; shrub or subshrub ..... ***S. xanti***
      12' Corolla white (sometimes lightly tinged blue); herbs or sometimes subshrubs 13
        13. Leaves deeply lobed ..... ***S. triflorum***
        13' Leaves unlobed or shallowly lobed 14
          14. Inflorescence 1–2-flowered; fruit white ..... ***S. adscendens***
          14' Inflorescence cymose to paniculate, usually with 2 or more flowers; fruits red, purplish, black, green or brown 15

15. Herbage villous, with some multicellular and some glandular hairs; calyx enlarged in fruit, covering lower half of fruit base; mature fruit in fresh material yellowish red to dark brown ..... ***S. physalifolium***
15' Herbage glabrous to strigose, the hairs all unicellular and non-glandular; calyx not enlarged in fruit; mature fruit in fresh material black to purplish, rarely green 16
16. Anthers greater than 2 mm long; corolla greater than 3 mm long ..... ***S. douglasii***
16' Anthers less than 1.5 mm long; corolla less than 2.5 mm long ..... ***S. americanum***

Solanum adscendens Sendtn. (ascending). Sonoita nightshade. —Annual herbs l0–40 cm tall, taller than wide, without tubers or stolons, unarmed, with some branches divergent, pubescent to hirsute. LEAVES alternate and sub-opposite, simple, lanceolate to ovate, 1–5 cm long, 1–2.2 cm wide, ca. 2 times as long as wide, the margin entire, the blade membranous; apex acute; base rounded to attenuate; petiole 3–20 mm long. INFLORESCENSES usually solitary flowers (rarely 2-flowered). FLOWERS actinomorphic; peduncle 6–15 mm long, narrowing at base, strongly deflexed; calyx 3–4 mm long, campanulate, more densely pubescent than leaves, the lobes longer than the tube, linear to oblong; corolla to 10 mm wide, rotate, white, drying yellow; stamens equal; anthers to 3 mm long, not adherent; filaments ca. 1/3 as long as anthers; style straight, about equal to stamens. FRUITS 5–8 mm in diam., milk-white, descending, not enclosed by the calyx; seeds 2.5–3 mm long, many, yellow-brown, lustrous, reniform. [*S. deflexum* Greenm.]. —In shade of shrubs along washes and hillsides, usually in sandy soils; pine-oak woodlands: Cochise, Pima, Pinal, Santa Cruz cos. (Fig. 1A); 1000–1700 m (3500–5600 ft); Aug–Sep; AZ to s Mex.; C. Amer.

Solanum americanum Mill. (of America). American black nightshade. —Annual or short-lived perennial herbs, sometimes turning woody with age, usually greater than 1 m tall, without tubers or stolons, unarmed; herbage glabrous to pubescent to variously strigose; stems terete to angled, sometimes with small, antrorsely curved teeth on the angles. LEAVES alternate or sub-opposite, simple, ovate to lance-elliptic, 2–9 cm long, 1–5 cm wide; margin entire to coarsely-toothed; base sub-truncate to attenuate; apex broadly acute to acuminate; petiole (1–)2–6(–8) cm long. INFLORESCENCES umbel-like racemes, lateral, borne between nodes or sometimes at nodes opposite leaves, (1–)3–8(–12)-flowered; peduncle 8–30 mm long. FLOWERS actinomorphic (Fig. 3A); pedicel 2–12 mm long; calyx 0.5–2 mm long, the lobes broadly lanceolate to rounded, about equal to or 1/2 as long as the tube; corolla rotate-stellate to reflexed, white or white tinged with purple, 2–6 mm in diameter; style included to 1 mm longer than anthers, pubescent ± half its length; stamens ± equal, (0.5–)1–1.5(–2) mm long; anthers connivent; filaments 1/2 or less as long as anthers, 1 mm long or less. FRUITS subglobose, 4–8 mm wide, green, orange-brown or blackish at maturity, not enclosed in the calyx; sclerotic granules 0–5; seeds orbicular, minutely pitted, 1–1.3 mm wide. —Agricultural areas, waste places and riparian areas: La Paz, Maricopa,

Mohave, Pima, Yavapai cos. (Fig. 1B); 50–1800 m (200–6000 ft); throughout the year; s. and w. U.S.; Mex; probably native to Eurasia.

Solanum americanum, *S. douglasii*, and *S. physalifolium* belong to the "*Solanum nigrum*" complex (also known as the "black nightshades"), a cosmopolitan group of about 30 species with a center of diversity in the New World tropics. They have been used by humans medicinally, for food and fodder, or as dyes, and reports of their use date back to the earliest records in written history (Edmonds 1985, Edmonds & Chweya 1997, Dehmer 2001, PBI *Solanum* Project 2009). Species related to black nightshades are also troublesome agricultural weeds and frequently hosts to destructive animals and diseases of crops. They are known to contain toxic levels of alkaloids, varying with climate, season and soil type (Ogg et al. 1981, Schilling & Andersen 1990).

The black nightshades are taxonomically challenging due to a variety of biological, environmental, and historical factors including polyploidy, their autogamous habit, ability to hybridize, phenotypic plasticity, and widespread geography (Stebbins & Paddock 1949, Schilling & Heiser 1979, Edmonds & Chweya 1997). Nomenclatural problems have also added to the confusion. Species related to *S. nigrum* have been reclassified innumerable times and there is extensive synonomy with over 300 published names (Ogg et al. 1981, Dehmer 2001, Knapp 2001).

The complex also has few consistent diagnostic morphological characters. Almost all authors acknowledge the difficulty assigning species names to dried specimens as well as the inconvenient necessity of large numbers of characters needed to differentiate taxa at the specific level (e.g., Soria & Heiser 1961, Heiser et al. 1979).

The nomenclature used here is tentative as the taxonomy is complicated and beyond the scope of this treatment. Arizona taxa may include more and/or different species than we recognize (e.g., Schilling 1981, Manoko et al. 2007). Variable and closely related forms in this group may represent "species in the making" and taxonomic subdivisions will certainly change over time.

Our approach in this treatment was to determine if it was possible to recognize discreet entities based on herbarium material from Arizona specimens. It appears there are three. The vegetative characters of *S. physalifolium* easily distinguish it from the other two. The differences between "*S. americanum*" and "*S. douglasii*", however, were more subtle. Past authors have used a variety of taxonomic characters in identification keys for the *Solanum nigrum* complex (e.g., habit, vestiture, inflorescence, corolla length, degree of style exertion, calyx in fruit, berry surface, seed size, number of sclerotic granules/fruit, pollen grain diameter, stomatal aperture length, chromosome numbers). We found overlap with almost all observable field characters and many of the others impractical when sorting out any reliable differences between them. However, anther length and to a lesser degree, corolla size, turned out to be consistent, albeit limited characters, for a useful separation of "*S. americanum*" and "*S. douglasii*". Although there are occasionally intermediates between the small-anthered "*S. americanum*" and larger-anthered "*S. douglasii,*" the boundaries were too vague to delineate a third taxon.

Solanum carolinense L. (from Carolina). Carolina horse-nettle, ball-nettle. —Perennial herbs, rhizomatous, without tubers, to 1 m tall, armed with prickles to 7 mm long, the surface covered with sessile stellate hairs throughout. LEAVES alternate, simple, ovate, to 12 cm long and 8 cm wide; margin with 2–4 lobes on each side; blade subcoriaceous, the lower surface densely covered with stellate hairs, with prickles along the main veins; petiole to 3 cm long; base cuneate to truncate; apex acute. INFLORESCENCES panicles, 4–10-flowered; peduncles to 5 cm long. FLOWERS zygomorphic (Fig. 3H); pedicels 7–15 mm long; calyx to 1 cm long, the lobes 1–2 times longer than the tube, equal, narrowly deltoid, acuminate; corolla campanulate, purple in ours, to 3 cm in diam., with stellate hairs along the midveins of the outer surfaces of the corolla lobes; stamens equal, to 12 mm long, the anthers 5 times as long as the filaments, not adherent; style exceeding the anthers by 2–10 mm; stigma subcapitate, to 1 mm wide. FRUITS to 2 cm in diam., not invested in the calyx, green with pale green to greenish grey markings when immature, yellow when mature, pendant; seeds lenticular, reddish brown, shiny, minutely pitted. —Known from only one site in Arizona along Queen Creek (*W.S. Radcliff s.n.*, ASU): Maricopa Co. (Fig. 1C); ca. 500 m (1500 ft); May; throughout the U.S.; e Can.

Solanum douglasii Dunal (for David Douglas). Greenspot nightshade. —Annual or short-lived perennial herbs, sometimes turning woody with age, usually less than 1 m tall, without tubers or stolons, unarmed; herbage glabrous to pubescent to variously strigose; stems terete to angled, sometimes with small, antrorsely curved teeth on the angles. LEAVES alternate or sub-opposite, simple, 2–9 cm long, 1–5 cm wide, ovate to lance-elliptic; margin entire to coarsely-toothed; base truncate to attenuate; apex broadly acute to acuminate; petiole (1–)2–6(–8) cm long. INFLORESCENCES umbel-like racemes, lateral, borne between nodes or sometimes at nodes opposite leaves, (1–)3–8(–12)-flowered; peduncle 8–30 mm long. FLOWERS actinomorphic (Fig. 3B); pedicel 2–12 mm long; calyx 1.5–2.5 mm long, the lobes lanceolate to rounded, about as long as to 1/4 the length of the tube; corolla rotate-stellate to reflexed, white or white tinged with purple, sometimes gland-dotted, sometimes with basal brownish star, 8–25 mm in diam.; style as long as stamens or up to 3 mm longer, pubescent ± half its length; stamens of ± equal length, (2.5–)3–4(–4.5) mm long; anthers connivent; filaments 1/5 or less as long as anthers, usually much less than 1 mm long. FRUITS subglobose, 6–12 mm wide, green, orange-brown or blackish at maturity, not enclosed in the calyx; sclerotic granules 0–5; seeds orbicular, minutely pitted, 1–1.6 mm wide. —Agricultural weeds also found in waste places and riparian areas: All cos. except Apache (Fig. 1D); 50–2500 m (~200–8000 ft); throughout the year; s. U.S. from AL to CA; Mex.; probably native to N. Amer.

Solanum elaeagnifolium Cav. (leaves like *Elaeagnus*). Silverleaf nightshade. —Perennial herbs, rhizomatous, without tubers, to 1 m tall, sparsely to copiously armed with prickles, these to 5 mm long, thin, delicate; surfaces covered with stellate hairs throughout. LEAVES alternate, simple, linear to oblong-lanceolate, to 10 cm long and 2.5 cm wide, the margin entire, sinuate-repand or

shallowly lobed; blade coriaceous, the lower surface densely covered with stellate hairs; petiole to 5 cm long; base attenuate, oblique, or rounded; apex acute. INFLORESCENCES panicles, 5–8-flowered; peduncles to 15 mm long. FLOWERS zygomorphic (Fig. 3C); pedicels to 2 cm long; calyx to 1 cm long, the lobes 1/2 as long to as long as the tube, unequal, linear; corolla rotate, purple or sometimes white, to 3.5 cm in diam., having stellate hairs along the midveins of the outer surfaces of the corolla lobes; stamens equal, to 13 mm long, the anthers 4 times as long as the filaments, not adherant; style exceeding the anthers by 2–10 mm; stigma clavate, to 1 mm wide. FRUITS to 1.5 cm in diam., not invested in the calyx, green with pale green to greenish grey markings when immature, yellow when mature, pendant; seeds lenticular, pale to dark brown, shiny and minutely pitted. —Disturbed areas: all cos. (Fig. 1E); below 1200 m (4000 ft); Mar–Oct; s and w U.S.; Mex.

Solanum heterodoxum Dunal (Greek: *heteródoxos,* of another opinion). Melon-leaf nightshade. —Annual herbs, taprooted, without tubers or stolons, 30–70 cm tall, pubescent, densely armed with prickles 2–9 mm long; hairs 0.2–0.8 mm long, simple over most of the plant, frequently gland-tipped. LEAVES alternate, deeply dissected, bipinnatifid to compound, broadly ovate to obovate or deltoid, 4–11 cm long, with irregular-stellate trichomes on the lower surface, and simple, gland-tipped trichomes on the upper and lower surface, the stellate trichomes with 2–5 rays, the main veins armed with scattered prickles; petioles 2–7 cm long, armed with prickles; base of leaf or leaflets variable, acute to cordate; apices of ultimate lobes rounded to obtuse. INFLORESCENSES 4–10 cm long, raceme-like monochasial cymes, 5–9-flowered; peduncles 1–5 cm long. FLOWERS somewhat zygomorphic, perfect or having nonfunctional stigmas and abortive ovules in the terminal portions of the inflorescence; pedicel 0.5–2 cm long; calyx campanulate, the tube 1.5–2.2 mm long, the lobes deltoid, 2–5 mm long; corollas stellate-pentagonal, 1–1.7 cm wide, loosely folded between the lobes, violet to blue; stamens unequal; anthers oblong, of two sizes, the lowermost extended anther 3.5–5 mm long, purple-tinged, incurved at the tip, the upper shorter anthers 2–4 mm long and yellow; filaments ca. 1/5 as long as the anthers; styles slender, extending out beyond the anthers; stigmas 0.3–0.6 mm across. FRUITS spherical, 0.9–1.2 cm in diam., tightly invested by the densely armed, burr-like accresent tube of the calyx; seeds dark brown, 2.5–2.9 mm long, lenticular to broadly ovate, minutely pitted. [*Solanum mullus* Hort. Monsp. ex Dunal, *S. virginianum* Pav. ex Dunal]. —Silty, sandy, or gravelly soils of dunes, streambeds, washes, and open hillsides: Cochise, Graham, Maricopa, Santa Cruz, Yavapai cos. (Fig. 1F); 590–1650 m (1950–5400 ft).; Jun–Oct; NM; n and c Mex.

Whalen (1979) cites three varieties of *S. heterodoxum* as occurring in the United States and Mexico. *S. h.* var. *setigeroides,* with stems densely covered in needle-like prickles and pentagonal corollas with broadly deltoid lobes, is probably the only variety in AZ.

Solanum hindsianum Benth. (for Richard Brinsley Hinds). Hinds' nightshade, Tomatillo espinoso. —Shrubs to 2.5 m tall, without tubers or rhizomes, unarmed to sparsely armed with stout prickles to 10 mm long, the young growth covered with stellate hairs. LEAVES alternate, simple, oblong-lanceolate to ovate, to 6.5 cm long and 4.5 cm wide; blade coriaceous, lower surface densely tomentose, the hairs stellate; margin entire to undulate; petiole to 2.5 cm long; base rounded, truncate or oblique; apex acute to rounded. INFLORESCENCES racemes, with fewer than 5 flowers; peduncles to 3 cm long. FLOWERS actinomorphic; pedicel to 1.5 cm long; calyx to 2 cm long, the lobes 2–3 times longer than the tube, unequal, linear to narrowly deltoid; corolla rotate, purple in ours, to 5.5 cm in diam., having stellate hairs along the midveins of the outer surfaces of the corolla lobes; stamens unequal, to 13 mm long, the anthers 3–4 times as long as the filaments, not adherent; style equal to or exceeding the anthers by 1–8 mm; stigma capitate, to 1 mm wide. FRUITS to 2 cm in diam., not invested in the calyx, green with pale green to greenish grey markings when immature, dark brown when mature, erect; seeds lenticular, dark brown, shiny, minutely pitted. —Rocky hillside, often among boulders: known only from Organ Pipe Cactus National Monument, Pima Co. (Fig. 2A); 500–600 m (1500–1800 ft); Mar; Son., Baja C., Mex.

Solanum jamesii Torr. (for Edwin James). Wild potato. —Perennial herbs, 10–30(–50) cm tall, glabrous to pilose and somewhat glandular, with rhizomes bearing tubers, these about (5–)10–15(–20) mm in diam.. LEAVES alternate, pinnately compound, 7–15 cm long, 4–9 cm wide, upper surface glabrous or nearly so, the lower surface with short glandular hairs; leaflets (5–)7–9(–13), linear-elliptic to lanceolate, usually 2–3 times longer than wide, the lowermost leaflets much reduced; small interstitial leaflets rarely interposed between the larger leaflets; leaflet base oblique, often decurrent on rachis; leaflet apex acute; most distal lateral leaflets (1.7–)2.5–5(–6) cm long, 0.5–1.5(–2) cm wide; terminal leaflet usually only slightly larger than laterals, (2.5–)3–6.5 long, (0.6–)1–2(–2.5) wide; petioles to 3 cm long. INFLORESCENCES paniculate cymes, lateral or pseudoterminal on leafy branches, few to several-flowered, ebracteate; peduncle 1–6 cm long. FLOWERS actinomorphic (Fig. 3F); pedicels 1–3 cm long, articulate near mid-point; calyx up to 8 mm long; lobes 1–3 times longer than tube, irregular, triangular-ovate, acuminate to caudate; corolla rotate-stellate, white, 2–3.5 cm in diam.; lobes ca. 2 times as long as tube, ovate-lanceolate to triangular-lanceolate, subobtuse to subacuminate, pubescent distally especially along margins; stamens equal, 5–7 mm long; anthers 3–5 times longer than filaments; style usually exceeding stamens by 4–6 mm. FRUITS ca. 1 cm in diam., not enclosed by calyx, green throughout; seeds ovate, green-white, ca. 2 mm long. [*S. j.* var. *heterotrichium* Bitter, *S. j.* var. *sinclairii* Bitter & Correvon, *S. j.* subsp. *septentrionale* Bitter]. —Grasslands, juniper-pinyon woodlands, scrub deserts, oak thickets, coniferous and deciduous forests: Apache, Cochise, Coconino, Greenlee, Gila, Mohave, Navajo, Pima, Santa Cruz cos. (Fig. 2B); 1500–2600 m (5000–8500 ft); mid-Jul–early Oct; CO, TX, UT; n Mex.

A close relative to the cultivated potato; tubers have been reportedly used as a food source by some Native American tribes. This plant is highly variable and has been separated into several varieties by some authors. This treatment considers the complex to be a single variable species.

Solanum pinnatisectum Dun. occurs on some Arizona species lists due to a 1951 Donovan S. Correll annotation of an ARIZ (*32189*) specimen collected by Leslie Goodding (*#277*) in the Huachuca Mountains. This specimen was determined as *S. jamesii* by Spooner, Rodriguez, and van den Berg in 2001.

Solanum lumholtzianum Bartlett (for Carl S. Lumholtz). Lumholtz nightshade, Sonoran nightshade, Mala Mujer. —Annual herbs, taprooted, without tubers or stolons, 20–70 cm tall, pubescent, armed with prickles 4–9 mm long; hairs up to 0.7 mm long, simple over most of the plant, frequently gland-tipped. LEAVES alternate, deeply dissected, bipinnatifid to tripinnatifid or compound, broadly ovate, 5–13 cm long, with stellate trichomes and simple, gland-tipped trichomes on the upper and lower surface, the stellate trichomes with 4–5 rays, the main veins armed with scattered prickles; petioles 2.5–7 cm long, armed with prickles; base of leaf or leaflets variable, acute to subcordate; apices of ultimate lobes obtuse to acute. INFLORESCENSES 3–8 cm long, raceme-like monochasial cymes, 6–10-flowered, peduncles 0.5–3 cm long. FLOWERS somewhat zygomorphic, perfect or having nonfunctional stigmas and abortive ovules in the terminal portions of the inflorescence; pedicel 0.5–1.5 cm long; calyx campanulate, the tube 1.8–2.2 mm long, the lobes linear-lanceolate, 5–12 mm long; corollas stellate, 1.3–1.8 cm wide, yellow; stamens unequal; anthers oblong, of three sizes, the lowermost extended anther 6.5–8.6 mm long, occasionally purple-tinged, incurved at the tip, the two adjacent shorter anthers 5.6–7.5 mm long, also terminally incurved, the uppermost shortest pair 4.5–6 mm long; filaments ca. 1/4 as long as the anthers; styles slender, extending out beyond the anthers; stigmas to 0.5 mm across. FRUITS broadly ovoid, 1.1–1.4 cm in diam., tightly invested by the densely armed accresent tube of the calyx; seeds dark brown, 3–3.5 mm long, broadly ovate to suborbicular, radially ridged. —Sandy or gravelly soils of washes, stream-banks, hillsides, or occasionally roadsides: Pima, Santa Cruz cos. (Fig. 2C); 1020–1400 m (3350–4550 ft); Jul–Oct; s AZ; n Mex.

Solanum lycopersicum L. (Greek: *lycos*, wolf; *persikon*, peach). Tomato (derived from Nahuatl word *tomatl*). —Annual to perennial herbs without tubers or stolons; stems 1–3 m long, decumbent with age, fleshy, unarmed, pubescent with unicellular and uniseriate multicellular hairs, sticky-glandular, aromatic. LEAVES alternate, irregularly pinnately compound to pinnatifid, (10–)20–40 cm long, (3–)7–10 cm wide, with hairs like those on stem; primary lateral leaflets 3–4(–5) pairs, 2–5 cm long, 0.8–2.5 cm wide, ovate to elliptic; base oblique, truncate to cordate; apex acute-attenuate; margin dentate-crenate to shallowly lobed, more so near base; terminal leaflet usually larger than laterals, 3–6 cm long, 1.5–3 cm wide; small interstitial leaflets common; petiole 1.2–6 cm long. INFLORESCENCES few-flowered racemes, to 10 cm long, ebractate, rarely branched; peduncle 1.5–5 cm. FLOWERS actinomorphic, more than 5-merous in some cultivars; pedicels 1–1.2 cm long; calyx 0.5–1.2 cm long, with tube minute, the lobes linear; corolla 0.7–2.5 cm long, 1–2 cm in diam., pentagonal, yellow; lobes 2–4 times as long as tube, narrowly lanceolate, reflexed, sparsely pubescent on tips and margins; anthers connivent in a staminal column 0.6–0.8 cm long, this narrowly cone-shaped,

tapered and sterile at tip; filaments minute to 0.5 mm long; style 0.6–1 cm long, usually not exceeding in staminal column. FRUITS 1.5–2.5(–12) cm wide, yellow-green, orange to red; seeds 2.5–3.3 mm long, obovate, pale brown, narrowly winged at apex. [*Lycopersicon esculentum* Mill., *Lycopersicon lycopersicum* (L.) Karst. ex Farw., *Lycopersicon pyriforme* Dunal]. —Waste areas, abandoned fields, roadsides, riverbeds; typically collected near populated areas, no persistent populations occur in Arizona: Coconino, Maricopa, Yavapai cos. (Fig. 2D); 300–2100 m (1000–7000 ft); Apr–Sep; native to S. Amer., cultivated worldwide.

This species displays enormous variation in fruit shape and size. A small-fruited variety, called "*S. l.* var. *cerasiforme*" by some authors, have been suggested to be ancestral to the cultivated form, though recent work has shown this variety to be a mixture of wild and cultivated forms (Nesbitt & Tanksley 2002).

Solanum physalifolium Rusby (leaves of *Physalis*). Hairy nightshade. —Annual or short-lived perennial herb to 70 cm tall, without tubers or stolons, unarmed; herbage moderately to densely villous, with gland-tipped hairs, some multicellular; stems terete to angled. LEAVES alternate to sub-opposite, simple, lance-ovate to lance-elliptic, 2–6 cm long, 1–3 cm wide; margin entire to coarsely toothed; base truncate to attenuate; apex rounded to acuminate. INFLORESCENCES umbel-like racemes, lateral, borne between nodes or sometimes at nodes opposite leaves, (2–)4–8(–12)-flowered; peduncle 5–30 mm long. FLOWERS actinomorphic; pedicel 2–15 mm long; calyx 1–3 mm long, the lobes lanceolate to rounded, reaching about 1/4 to 2/3 the length of the tube; corolla actinomorphic, rotate to weakly campanulate (this sometimes not obvious in dried specimens), white or white tinged with purple, with basal brownish star, 3–6 mm in diam., with broadly triangular lobes; style as long as stamens or up to 1 mm longer, pubescent ± half its length; stamens of ± equal length, 1.5–2(–2.5) mm long; anthers connivent; filaments less than 1 mm long. FRUITS orbicular, 6–9 mm wide, dark green to purple to brownish-green, at least lower half of mature fruit covered with enlarged calyx; sclerotic granules 0–5; seeds 1–2 mm wide, orbicular, orange-brown in dried specimens. [*S. sarrachoides* Sendtn. and *S. villosum* (L.) Mill. have been misapplied]. —Infrequent in disturbed areas: Coconino, Maricopa, Navajo, Yavapai cos. (Fig. 2E); 900–2100 m (~3000–7000 ft); Jun–Oct; throughout N. Amer. excluding se states; introduced from S. Amer.

Solanum rostratum Dunal (beaked). Buffalobur nightshade. —Annual herbs, to 70 cm tall, without tubers or stolons, abundantly armed on herbage and calyx with straight, straw-colored prickles, these sometimes more than 1 cm long on fruiting calyces; copiously stellate-pubescent throughout (also with occasional simple hairs), the cauline stellae sessile or sometimes on a stalk up to 1 mm long. LEAVES alternate, (bi-)pinnatifid to pinnatisect near the base, the lobes irregular in shape with rounded or obtuse apices; blades elliptic to broadly ovate in outline, to ca. 12 cm long, submembranous to subcoriaceous, stellate-pubescent on both surfaces, prickly along principal veins, the veins impressed above; petioles to ca. 8 cm long, usually ca. 2/3 the length of the blade. INFLORESCENSES raceme-like monochasial cymes, to ca. 15 cm long; peduncles 1–4 cm long. FLOWERS

somewhat zygomorphic (Fig. 3D); pedicel to ca. 1 cm long; calyx 5–12 mm long, the lobes usually at least 2 times as long as the tube (sometimes much longer); corolla rotate, yellow, 15–25 mm in diam., stellate-pubescent on the outer surface, loosely folded between the lobes, the two lower lobes somewhat larger and curving outward; stamens unequal; anthers ca. 2 times longer than filaments, the lowermost anther greater than 1 cm long, red-purple tinged, curved, the 4 uppermost anthers 6–8 mm long, yellow, straight; style curved, equal to or exceeding the long anther. FRUITS 9–12 mm in diam., erect, closely invested by the densely prickly, accrescent tube of the calyx; seeds flattened, ovoid, dark brown, alveolate. [*Androcera rostrata* (Dunal) Rydb.]. —A common weed of overgrazed pastures and roadsides: all cos. except La Paz, Yuma (Fig. 2F); 250–2250 m (800–7400 ft); Jun–Sep; all states except FL; throughout Mex. and s Can.

Solanum stoloniferum Schltdl. (bearing stolons). Fendler's wild potato. —Perennial herbs, 10–15(–50) cm tall, pilose throughout, with stolons and tubers; tubers round to ellipsoid, white to purple, up to 3 cm long. LEAVES alternate, pinnately compound, usually about 7.5–22 cm long, 3.5–8 cm wide, more or less pubescent on upper and lower surfaces; leaflets (3–)5–7(–9), mostly less than 2 times longer than wide, with younger leaflets sometimes purple beneath; most distal lateral leaflets (1.5–)2.5–6.5 cm long, (0.5–)1.5–2.7(–3.5) cm wide, ovate to elliptic, with apex acute to acuminate, with base cuneate to rounded-oblique, often decurrent on rachis; terminal leaflet usually much larger than laterals, (1.8–)3.5–7.5(–10) cm long, (1.5–)2.5–4.5(–7) cm wide, elliptic to obovate, with apex acute to acuminate, with base cuneate; small interstitial leaflets sometimes present between the larger ones; petioles 1.5–4 cm long. INFLORESCENCES racemose or paniculate cymes, lateral or pseudoterminal, 3–26-flowered, ebracteate, usually densely pilose and sometimes sparsely glandular; peduncles 3.4–10 cm long. FLOWERS actinomorphic (Fig. 3G); pedicles 1–3.5 cm long; calyx 4–7(–30) mm long, with lobes 1–2 times as long as tube, ovate-lanceolate to triangular-lanceolate, acute to long-attenuate; corolla pentagonal-rotate, blue, purple or white and purple-tinged, ca. 1.8–3.3 cm in diam., with lobes 1.5–4 mm long, edges of corolla flat; stamens equal, 3–6 mm long; anthers 2–4 times longer than filaments; style as long as stamens, or exceeding them by up to 4 mm. FRUITS 0.9–1.7 cm in diam., not invested in calyx, white to deep green, sometimes with darker green stripes and white spots; seeds ovate in outline, green-white, ca. 2 mm long. [*Solanum fendleri* A. Gray]. —Open coniferous forest: Apache, Cochise, s Coconino, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz cos. (Fig. 2G); 1950–2750 m (6500–9000 ft), occasionally lower; late Jul–early Oct; NM, TX, s to Oax., Mex.

One of the most common, widespread, and polymorphic species of the wild potatoes. Arizona populations tend to be of shorter stature and have fewer interstitial leaflets than in the southern part of its range. Tubers have been reportedly used as a food source by some Native American tribes.

Solanum triflorum Nutt. (three flowers). Cutleaf nightshade. —Annual herbs, 10–50 cm tall, unarmed, without tubers or stolons, sparsely to densely appressed pubescent; stems divergent, spreading to decumbent. LEAVES simple, alternate, oblong to ovate, deeply pinnatifid, 2–5 cm long, 1–2 cm wide, ca. 2 times as long as wide, with individual lobes lanceolate, the blade submembranous; petiole 5–20 mm long; apex acute; base cuneate. INFLORESCENSES umbels with (1–)2–3(–6)-flowered; peduncle 5–15 mm long. FLOWERS actinomorphic (Fig. 3E); pedicel up to 5 mm long; calyx 2.5–5 mm long, campanulate, the lobes longer than tube, linear, acute; corolla white, drying yellow, up to 8 mm wide; stamens equal; anthers 2.5–3 mm long, not adherent, straight; filaments about as long as anthers; style about as long as stamens. FRUITS 9–14 mm in diam., green, ascending, not enclosed by calyx; seeds 2.5–3 mm in diam., many, sub-orbicular, flat, yellow-brown. —Roadsides, washes, sandy soil, dry scrub lands, juniper woodlands: Apache, Cochise, Coconino, Gila, Maricopa, Mohave, Navajo, Pinal, Yavapai cos. (Fig. 2H); 600–2600 m (2000–8500 ft); May–Sep; c U.S.; native to S. Amer.

In times of food shortage the Indians of west central NM boiled the berries, ground them with chili and salt, and ate them as a condiment with mush or bread (Ebeling 1986).

Solanum xanti A. Gray (for L. I. Xantus). Purple nightshade. —Subshrub, woody at base, 40–90 cm tall, unarmed, without tubers or stolons, puberulent to soft -pilose mainly on stems and veins of leaves. LEAVES simple, elliptic, ovate or lanceolate, 1–5 cm long, 0.5–2 cm wide, ca. 2 times as long as wide, submembranous, the margin entire or rarely with occasional teeth; apex acute to rounded; base rounded to oblique; petiole 5–15 mm long. INFLORESCENSES an umbel-like panicle with up to 6 flowers; peduncle 5–2 mm long. FLOWERS actinomorphic (Fig. 3I); pedicel 5–15 mm long; calyx up to 7 mm long and wide, campanulate, the lobes deltoid, shorter than the tube; corolla deep blue to lavender, 15–30 mm wide; stamens equal; anthers 4–5 mm long, not adherent, opening by a short slit; filaments up to 1/3 as long as the anthers; style longer than the stamens. FRUITS 10–15 mm in diam., green, not enclosed by the calyx; seeds 1.5–2 mm in diam., numerous, yellowish brown, reniform. —Rocky bajada slopes in chaparral: Coconino, Gila, Graham, Greenlee, Maricopa, Mohave, Navajo, Pima, Santa Cruz, Yavapai cos. (Fig. 2I); 1000–2100 m (3000–7000 ft); Apr–Nov; AZ, CA; Baja C., Mex.

Native Americans of the central valley of California ate the berries raw (Ebeling, 1986).

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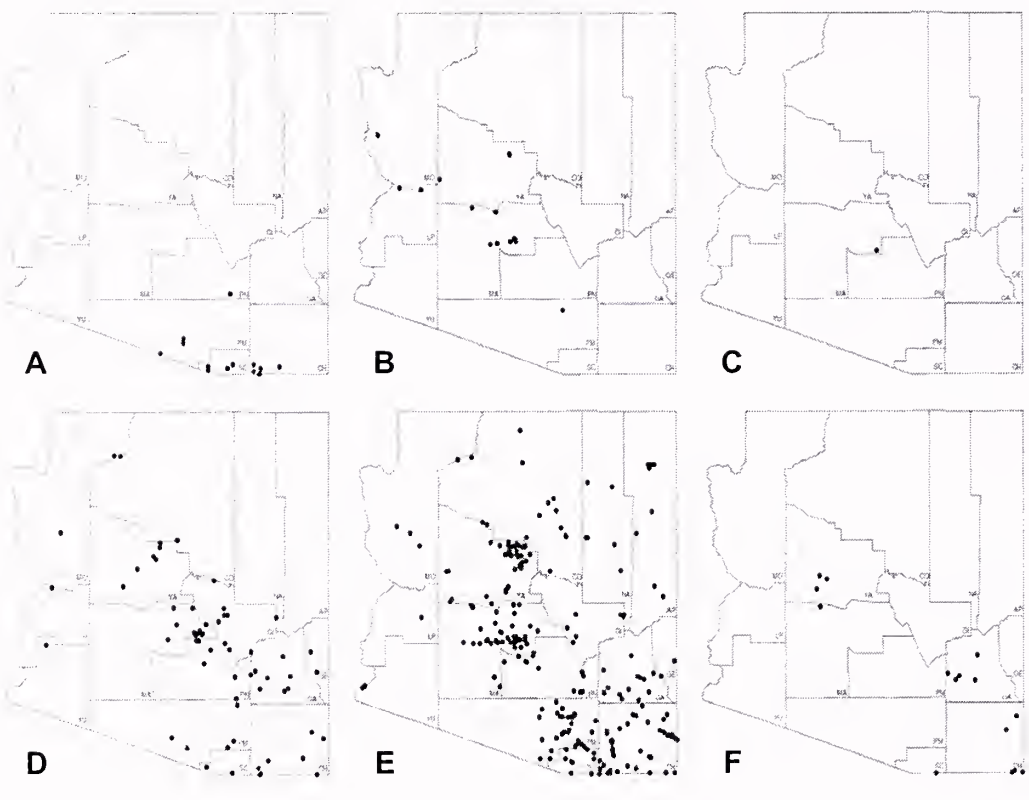
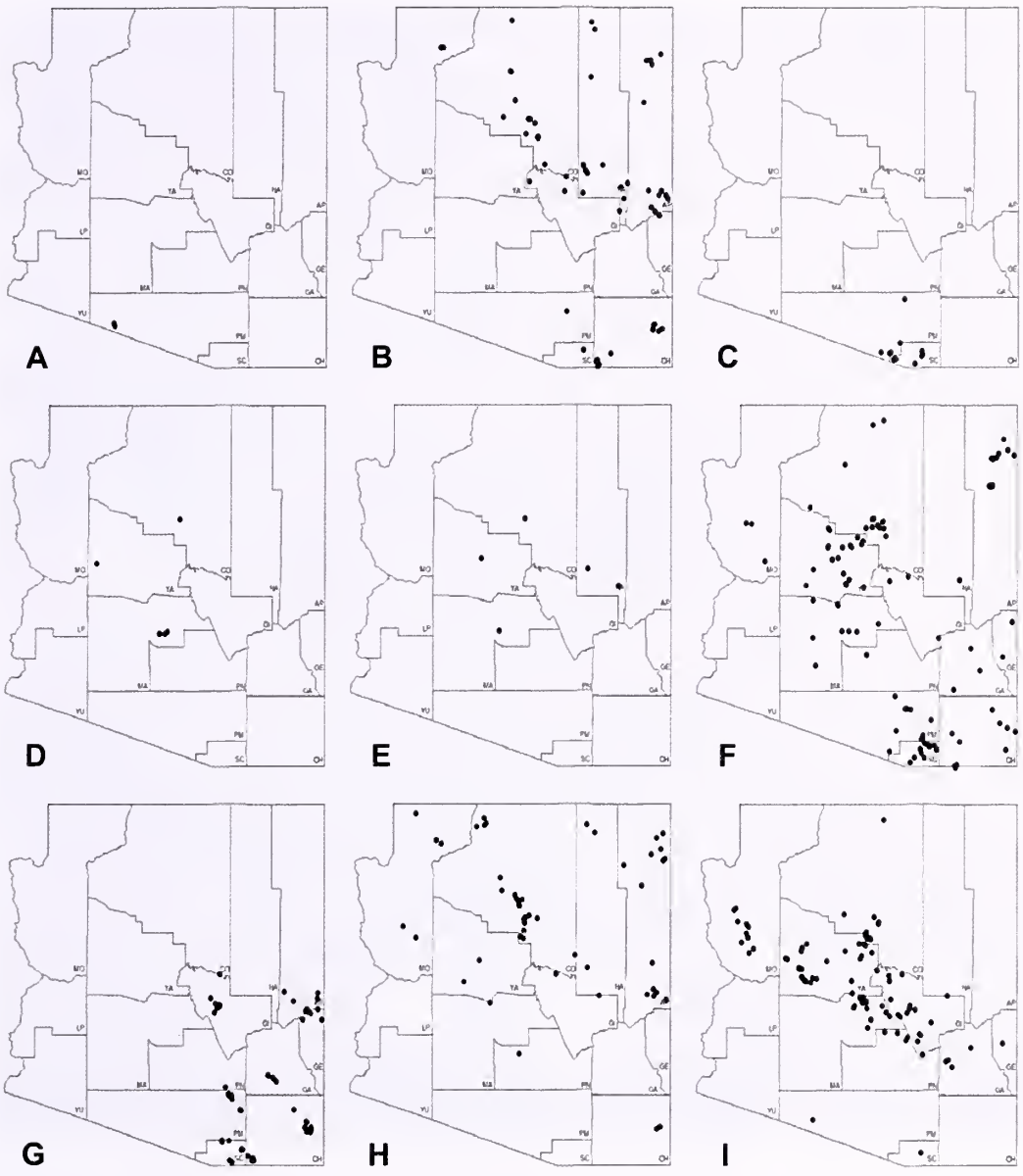


Solanaceae Figure 1. Distribution of: (A) *Solanum adscendens*; (B) *Solanum americanum*; (C) *Solanum carolinense*; (D) *Solanum douglasii*; (E) *Solanum elaeagnifolium*; (F) *Solanum heterodoxum*.



Solanaceae Figure 2. Distribution of: (A) *Solanum hindsianum*; (B) *Solanum jamesii*; (C) *Solanum lumholtzianum*; (D) *Solanum lycopersicum*; (E) *Solanum physalifolium*; (F) *Solanum rostratum*; (G) *Solanum stoloniferum*; (H) *Solanum triflorum*; (I) *Solanum xanti.*

Solanaceae Figure 3. *Solanum* species in flower. (A) *Solanum americanum*; (B) *Solanum douglasii*; (C) *Solanum elaeagnifolium*; (D) *Solanum rostratum*; (E) *Solanum triflorum*; (F) *Solanum jamesii*; (G) *Solanum stoloniferum*; (H) *Solanum carolinense*; (I) *Solanum xanti* (Photos B, D, E, G, & I by Max Licher; A, C & F by Elizabeth Makings; and H by Raul Gutierrez).

SOLANACEAE PART THREE:

LYCIUM L. WOLF BERRY, DESERT THORN

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Shrubs or small trees, usually thorny. LEAVES alternate, simple, usually in fascicles, more or less succulent. FLOWERS in leaf axils, solitary or in groups of 2–6, pedicellate; calyx tubular to campanulate, generally ruptured by growing fruit, sometimes slightly accrescent, 2–6-lobed, the lobes deltate to linear or ovate; corolla white to greenish (sometimes tinged with lavender) to purple, tubular to funnelform or narrowly campanulate, with 4–6 spreading or reflexed lobes; stamens 4–6, included or exserted; filaments filiform, subequal or unequal, adnate to corolla tube proximally, often pubescent near base of free portion, sometimes enlarged and glandular at the base; anthers oval, dorsifixed, longitudinally dehiscent; style slender; stigma shortly 2-lobed; ovary 2-loculed, the locules with 1 to many ovules. FRUITS berries (sometimes with hardened endocarps and thus drupe-like), fleshy to dry; seeds 2–many, flattened, minutely pitted, sometimes enclosed in a hardened endocarp. —ca. 80–90 (10 in AZ) species in tropical and subtropical regions of the world (Hitchcock 1932 & 1981, Chiang-Cabrera 1981).

Species of *Lycium* seem to present various degrees of dioecy and sometimes have quite different forms of flowers on different plants (e.g., pin and thrum flowers on different individuals in *L. exsertum* and *L. fremontii*; Miller & Venable 2000). *Lycium californicum* has been found to have diploid populations with hermaphroditic flowers and tetraploid populations with sexually dimorphic flowers (Yeung et al. 2005).

The fruits of Lycium are often edible and have been widely used by Native Americans and others in the Southwest (Hodgson 2001).

Vascular Plants of Arizona: Solanaceae Part Three: *Lycium*. *CANOTIA* 5 (1): 17–26, 2009.
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1. Calyx lobes 2.5–6 mm long (before tearing between the lobes), about 1/3 as long as the calyx-tube to longer than the calyx-tube; corolla lavender, white to cream or green 2
   2. Calyx generally truncate at base; corolla-lobes reflexed; sides of corolla nearly straight; stamens generally not exceeding corolla tube; fruit constricted laterally at about the middle or somewhat below; fruit with hardened endocarp enclosing seeds 3
      3. Calyx-lobes about as long as calyx-tube or up to 2 times as long as the tube; calyx sparsely pubescent ..... ***L. macrodon***
      3' Calyx-lobes shorter than calyx-tube; calyx moderately pubescent ..... ***L. cooperi***
   2' Calyx rounded to attenuate at base; corolla-lobes spreading to erect; sides of corolla tube curved outward; stamens exceeding the corolla tube; fruit subglobose to pyriform, not constricted; fruits without hardened endocarp 4
      4. Flowers 8–12 mm long; corolla tube narrowly campanulate to narrowly obconic; leaves glandular-pubescent ..... ***L. parishii***
      4' Flowers 15–25 mm long; corolla tube elongate-funnelform, conspicuously expanded at the top; leaves glabrous ..... ***L. pallidum***
1' Calyx lobes 0.5–2.5 mm long (before tearing between the lobes), usually less than 1/3 as long as the calyx-tube; corolla white, lavender to dark purple 5
   5. Plants glabrous or nearly so 6
      6. Flowers about 4–7 mm long, the calyx about half as long as flower 7
         7. Flowers appearing in early spring, 4-merous; leaves subglobose, to oblong, terete in cross section when fresh; twig bark gray to whitish; low desert, often with *Atriplex polycarpa* ..... ***L. californicum***
         7' Flowers appearing mainly with monsoon rains in summer and fall, (4-)5-merous; leaves much wider than thick, flat in cross section; twig bark often dark reddish brown; usually in upland Sonoran Desert ..... ***L. berlandieri***
      6' Flowers usually over 7 mm long, the calyx about 1/4 as long as the flower 8
         8. Corolla-lobes lanate-ciliate at margin ..... ***L. torreyi***
         8' Corolla-lobes glabrous ..... ***L. andersonii***
   5' Plants glandular-pubescent 9
      9. Flowers mainly whitish with little blue or purple, mainly pendant; stamens often exserted; filaments densely pubescent; usually growing in upland habitats; seeds 25–35 ..... ***L. exsertum***
      9' Flowers mainly dark purple, tending to be erect; stamens usually not exserted; filaments glabrous or sparsely pubescent; usually growing in low, often salty areas; seeds 40–60 ..... ***L. fremontii***

Lycium andersonii A. Gray (for C. L. Anderson, collector of the type). —Shrub 0.5–3 m tall, densely branched, rounded, thorny, glabrous or essentially so in ours; young branches flexuous, silvery-white to tan, the older branches with silvery-tan to dark brown bark. LEAVES linear-terete, linear-spatulate, spatulate, or obovate, more or less succulent, 3–35 mm long, 1–8 mm wide, sessile or with a petiole 1–3 mm long; apex rounded to acute; base attenuate. FLOWERS with pedicels 1–10 mm long, borne singly or in pairs in the leaf fascicles, white to pale purple (Fig. 2C); calyx cup-shaped, 1.5–3 mm long, 4–5-lobed or sometimes irregularly 2-lipped, the lobes triangular, about 1/4 the length of the calyx-tube, the margins sparsely ciliate; corolla 4–16 mm long, tubular or very narrowly funnelform, the lobes 4–5, ovate, 1.5–2 mm long, ciliolate, spreading; stamens

hardly exserted to exserted 2–3 mm; filaments adnate to lower corolla-tube, their bases glabrous or sparsely hairy; style varying in length, from shorter than to as long as or longer than the stamens. FRUITS red or orange-red, 3–9 mm long, ovoid or ellipsoid, many-seeded. $n = 12$. —Deserts, usually along washes: all cos. except Apache and Greenlee (Fig. 1A); 250–1700 m (800–5600 ft); mainly Jan–Mar, but occasionally at other times; s CA, NV, UT, w NM; n Mex.

A variable species of perhaps four varieties, three of which occur in AZ and intermix: *L. a.* var. *wrightii* with 4-lobed flowers 4–8 mm long, *L. a.* var. *andersonii* with 4–5-lobed flowers 8–16 mm long and leaves 3–16 mm long, and *L. a.* var. *deserticola* with 4–5-lobed flowers 8–16 mm long and leaves 20–35 mm long.

Lycium berlandieri Dunal (for J.-L. Berlandier, collector of the type). —Shrub 0.7–2.5 m tall, rather sparingly branched, with few thorns at the end of branches, or practically unarmed; branches somewhat crooked, decumbent or flexuous, tan to silvery-gray, the older stems often dark reddish brown. LEAVES glabrous, linear to spatulate-obovate, 1.5–6(–15) mm long, 1–2.5(–4.5) mm wide, rounded, sometimes acute or emarginate at the apex, fascicled. FLOWERS solitary or in groups of 2–3 in the leaf fascicles; pedicels 3–20 mm long; calyx cup-shaped, 1–3 mm long, 3–5-lobed, the lobes deltoid, about one third as long as the tube, equal or unequal, the calyx frequently splitting to the base on one side, with a small tuft of hair at the tip of each lobe; corolla white or pale lavender, obconic-funnelform, constricted immediately above the ovary, 4–9 mm long, the lobes 4–5, 1/6–1/3 the length of the tube, usually reflexed; stamens unequal or subequal, included to long-exserted; filaments adnate to a point between 1/3 and nearly 1/2 the length of the corolla-tube, hairy for the first third of their free portion, adjacent corolla-tube hairy, the portion below the insertion of the filaments from almost glabrous to densely hairy; style equaling the stamens in length or surpassing them. FRUITS globose, 5 mm in diameter, many-seeded (Fig. 2J). —Sonoran Desert, along washes: La Paz, Maricopa, Pima, Pinal, Santa Cruz, Yavapai,Yuma cos. (Fig. 1B); 350–900 m (1200–3000 ft); mainly Jul–Sep, but occasionally at other times; s CA to TX, OK; s to Tamps., S.L.P., Hgo., and Baja C. Sur, Mex.

Lycium californicum Nutt. ex Gray (of California). —Shrub, usually no more than 0.5 m tall in ours, intricately branched, decumbent or spreading, the branchlets usually tipped with short blunt thorns, otherwise unarmed. LEAVES glabrous, fleshy, subterete, ovoid or spatuloid, 2–25 mm long, 1–3 mm wide, 2–8 in a fascicle, subsessile. FLOWERS 1–3 in the axils, on pedicels 1–5 mm long (Fig. 2F); calyx campanulate, 2–2.5 mm long, 2–4-lobed, the lobes about 1/3 the length of the tube, broadly triangular, puberulent, usually ciliolate, or calyx laterally compressed, with 2 well-developed keeled lobes and 2 obsolete ones; calyx not keeled, with 4 subequal lobes, much shorter than length of the tube; corolla white to pale purple, the tube 2–4.5 mm long, the lobes 4, oblong-ovate, about as long as the tube or slightly shorter than it, spreading or reflexed, sparsely ciliolate; stamens 4, exserted; filaments adnate a little above the middle of the corolla-tube, the base of the free portion and adjacent corolla-tube densely hairy; style usually surpassing the stamens. FRUITS ovoid, 2–4 mm long, orange-red or red, with thin succulent

exocarps, endocarps much hardened, the carpels separating rather readily at maturity, each carpel 1-seeded. $n = 12, 18, 24$. —Low sparse desert with apparently poor drainage and hard saline soils, often associated with *L. fremontii* and *Atriplex polycarpa* (Fig. 3A): Maricopa, Pima, Pinal cos. (Fig. 1C); 350–450 m (1200–1500 ft); Jan–Mar; CA; n Mex.

A species of four varieties; in AZ only *L. c.* var. *arizonicum* A. Gray is found, which differs from other varieties in its extremely fleshy globular to pyriform leaves and uncompressed calyx with subequal calyx-lobes.

Lycium cooperi A. Gray (for J. G. Cooper, collector of the type). —Shrub 0.6–2 m tall, stout, densely branched, thorny, the branches thick and rigid, silvery to purplish or tan to reddish when old, minutely glandular-puberulent when young. LEAVES 3–10 in fascicles, spatulate, oblanceolate, or obovate-spatulate to broadly obovate, 1–3.5 cm long, 0.4–1.3(–2.3) cm wide, densely glandular-pubescent or hispidulous to glabrescent; apex rounded to truncate; base attenuate; midvein and some of the lateral veins distinct. FLOWERS numerous, pendant, 1–3 in a fascicle, the pedicels about the same length as the calyx or shorter, glandular-pubescent; calyx bowl-shaped or oblong-campanulate, 4–14 mm long, glabrate or glandular-pubescent, expanding and usually rupturing with the growth of the fruit (Fig. 2E); corolla greenish white with purple veins, broadly funnelform to nearly cylindric, slightly expanded at top, densely pubescent to glabrous externally, the tube 8–15 mm long, the lobes 5, 1/4 to 1/5 the length of the tube, triangular-ovate, spreading or reflexed, with margins usually ciliate; stamens about equalling the corolla-tube or slightly included; filaments subequal, adnate from about middle of corolla-tube to about 3/4 the length; vascular strands leading to filaments very sparsely pilose at the base, the free portion of filaments glabrous; style shorter than filaments or equalling them. FRUITS ovoid, greenish yellow, 5–10 mm long, constricted at about the middle or above; seeds 1–2 in upper portion, several (5–8) in lower half. $n = 12$. —Mohave Desert in AZ, in washes, flats and slopes in rocky to sandy soils: La Paz, Mohave, (perhaps Yuma) cos. (Fig. 1C); 400–1400 m (1300–4600 ft); Mar–Apr; s CA, NV, and UT.

Lycium exsertum A. Gray (presumably for exserted stamens). —Shrub 1–4 m tall, openly branched, sparingly armed, the branches rigid, densely pubescent when young, the bark dark gray or brown to reddish brown. LEAVES spatulate to obovate, 5–25 mm long, 3–8 mm wide, obtuse or rounded at the apex, rarely acute, densely glandular-pubescent, attenuate to a petiole 3–5 mm long, densely glandular-puberulent. FLOWERS pendant, single or in groups of 2–3 (Fig. 2A); pedicels 3–6 mm long; calyx tubular-campanulate, 2.5–6 mm long, densely pubescent; lobes 5, 1/4 to 1/2 the length of the tube, equal, or the calyx irregularly lobed and more or less two-lipped, then some lobes as long as the tube; corolla funnelform, slightly narrowed just above ovary, 7–14 mm long, whitish, greenish, or tinged with purple and brown, glabrous externally; lobes 5, broadly ovate or obovate, pale lavender, spreading, 1–2 mm long, with sparsely ciliolate or glabrous edges; stamens 5, subequal, from slightly to 2–3 mm exserted from the corolla-tube; filaments adnate to a point between a little below the middle of the corolla-tube, densely pilose on the

lower 2/3 of their free portion; corolla-tube densely hairy from the base to the point of adnation of the filaments, then less densely hairy up to the point where the filaments cease to be hairy; anthers 1–2 mm long; style usually slightly shorter than the stamens, and only slightly exserted but sometimes long-exserted. FRUITS ovoid, 6–8 mm long, 20–35-seeded. $n = 24$. —Upper Sonoran Desert in AZ, in washes and on mountain slopes: Coconino, Gila, Graham, La Paz, Maricopa, Mohave, Pima, Pinal, Santa Cruz, Yavapai cos. (Fig. 1D); 300–1400 m (1000–4600 ft); Jan–Apr; s to Baja C. Sur, Son., and Sin., Mex.

The distinction between *Lycium exsertum* and *L. fremontii* is usually not difficult in living plants but often so with dried specimens as habitat and flower color are important. The species are compared directly in lead 9 of the key.

Lycium fremontii A. Gray (for J. C. Frémont). Frémont's wolf-berry. —Shrub, stout, intricately branched, 1–3 m tall, sparingly armed or unarmed, with densely glandular-puberulent foliage, rarely almost glabrous; bark tan to dark gray or brown. LEAVES spatulate, oblanceolate or obovate, 8–35 mm long, 2–15 mm wide, acute to rounded at apex, in fascicles of 3–6, single in young branches. FLOWERS pedicels 4–25 mm long, glandular-puberulent (Fig. 2B); calyx tubular (2–)4–8(–10) mm long, 5-lobed, the lobes triangular, mostly less than 1 mm long, rarely 2 mm; corolla tubular to funnelform, deep lavender or violet to white with purple veins, 8–15(–20) mm long, the lobes orbicular to broadly obovate, glabrous to puberulous on adaxial surface, 1/4 to 2/5 the length of the tube, spreading, the margins smooth to densely ciliate; stamens unequal, usually included within the tube or slightly protruding from it; filament-adnation variable, from about middle of corolla-tube to about 1/3 from the base, the filaments glabrous to densely pilose at base of the free portion, the adjacent corolla-tube glabrous or very sparsely pubescent; style about equaling the corolla-tube or slightly exceeding it, sometimes much shorter than the stamens. FRUITS oblong-ovoid, 5–9 mm long, red, 40–60-seeded. $n = 48, 60$. —Lower Sonoran Desert in AZ, in washes and in flats, often in saline soils: all cos. except Coconino, Navajo and Santa Cruz (Fig. 1E); 100–1300 m (300–4300 ft); mainly Jan–Apr, occasionally at other times; CA; Baja C., Baja C. Sur, Son., Mex.

Lycium macrodon A. Gray (large toothed, for large calyx-lobes). —Shrub 1–3 m tall, rigidly branching, thorny; young branches silvery gray, scarcely to densely glandular-pubescent; old branches dark brown to black, glabrescent; thorns straight. LEAVES linear-spatulate to obovate or oblong-lanceolate, 5–30(–35) mm long, 2–5(–12) mm wide, acute to rounded at apex, tapering to a petiole 1–2 mm long or sessile, bright green, glabrous or minutely puberulent, sometimes with white veins, fascicled in groups of 3–6. FLOWERS pendant, solitary or in pairs at the leaf fascicles (Fig. 2D); pedicels minutely puberulent, 1–7 mm long; calyx campanulate, 4–9 mm long, minutely glandular-puberulent; calyx-lobes 5, as long as the calyx tube or up to 2 times as long as the tube, subulate to linear-lanceolate, acute; corolla-tube greenish white, 6–12 mm long, glabrous to sparsely puberulent externally; lobes 5, greenish white to pale lilac with dark veins, ovate to oblong, sparsely to densely ciliolate, 2–5 mm long, rotate to reflexed; stamens subequal, barely exserted

to exserted 2–4 mm; filaments adnate to corolla-tube from base to a little below the middle, pilose from near base of the corolla to 4 mm on free portion, or almost glabrous; style included or 1–4 mm longer than the stamens. FRUITS constricted below the middle, yellowish to brownish when ripe, 6–10 mm long, notched at the apex; upper part of each locule bearing 1–2 seeds enclosed in an indurated endocarp; lower part fleshy, bearing 1–5 abortive ovules. $n = 12$. —Lower Sonoran Desert in AZ, in washes and in flats: La Paz, Maricopa, Pima, Pinal, Yuma cos. (Fig. 1F); 250–750 m (800–2500 ft); mainly Feb–Apr, occasionally at other times; Son. Mex.

Lycium pallidum Miers (pallid, pale, for the glaucous green foliage). —Shrub 1–2 m tall, dense, intricately branched, thorny; branches often flexuous, yellowish, gray, or reddish to purplish black, glabrous or very sparsely puberulent; thorns slender and sharp. LEAVES 1–5 cm long, 3–15 mm wide, glaucous green, glabrous, oblong-spatulate or oblanceolate to broadly elliptic; apex acute or rounded; base attenuate into a short petiole, the midvein and primary lateral veins usually visible. FLOWERS pendulous, borne singly or in groups of 2–3 (Fig. 2G); pedicels slender, 4–16 mm long; calyx cup-shaped to campanulate, blue-glaucous, glabrous, 5–8 mm long, 5-lobed, the lobes lanceolate to ovate or elliptic, equalling or exceeding the tube in length, their margins sometimes sparsely pubescent; corolla-tube elongate-funnel form, 12–25 mm long, expanded conspicuously at the top, from white to lavender purple, most commonly greenish with purple veins, the 5 lobes oval or rhombic, 1/5 to 1/3 the length of the tube, their margins commonly remotely ciliolate; stamens exserted; filaments adnate to a little below the middle of the corolla-tube, the free base of the filaments and the adjacent corolla-tube pilose, or the filaments densely hairy nearly to top of corolla-tube; style varying in length from about equal to stamens to surpassing them. FRUITS red or reddish blue due to glaucescence, ovoid, about 1 cm or slightly less in diameter, 4–50-seeded. $n = 12$. —Desert grassland, riparian areas, chaparral, pinyon-juniper woodland: all cos. except La Paz, Maricopa, Santa Cruz, Yuma (Fig. 1G); 800–2250 m (2500–7400 ft); Mar–Jun, occasionally at other times; CA to TX, n to UT and CO; Coah., N.L., S.L.P., Mex.

Lycium parishii A. Gray (for S. B. and W. F. Parish, collectors of the type). —Shrub, profusely branched, thorny, 1–3.5 m tall, with glandular pubescence and silvery to dark gray or brown bark. LEAVES obovate-spatulate or elliptic, 1–4 in a fascicle, 3–12 mm long, 1–5 mm wide, rounded to obtuse at apex; petiole indistinguishable from the lamina, densely pubescent, sometimes cinereous. FLOWERS erect, borne singly or in pairs, pedicels 2–10 mm long, pubescent; calyx campanulate, densely pubescent, tube 2–3 mm long, lobes 5, elliptic or oblong-oval, apex rounded to acute, half as long as or longer than the tube; corolla with greenish purple throat externally, tube narrowly campanulate to narrowly obconic, contracted above the ovary, 6–10 mm long, 2–3.5 mm broad at the throat, lobes 5, pale lavender, with darker lavender marks, spreading, ovate, 2–3 mm long, with ciliolate margins; stamens exserted due to spreading of the corolla-lobes, about equalling them in length; filaments adnate to lower half of corolla-tube, densely pilose on lower fourth of free portion; style equalling stamens. FRUITS red, ovoid, 4–7 mm

long, 3–5 mm thick, 7–15-seeded (Fig. 2I). n = 12. —Washes, alluvial fans in Sonoran Desert; La Paz, Maricopa, Mohave, Pima, Pinal, Yavapai, Yuma cos. (Fig. 1H); 250–1200 m (800–3900 ft); Feb–Sep; CA, NV; Son., Baja C., Mex.

Lycium torreyi A. Gray (for J. Torrey). —Shrub 1–3 m tall, much branched, spreading, with yellowish tan to brownish bark, unarmed or with few thorns. LEAVES pale green, somewhat succulent, spatulate to oblanceolate or obovate, acute or obtuse at the apex, 1–3(–5) cm long, 0.3–1(–1.5) cm wide, attenuate at base to a petiole 2–4 mm long. FLOWERS abundant, in groups of 1–6(–8), on slender pedicels 5–20 mm long; calyx cup-shaped to tubular, 2.5–6 mm long, glabrous to sparsely pubescent, the lobes 5, triangular, 1/4 to 1/2 the length of the tube, their margins lanate-ciliate, glabrescent with age; corolla-tube narrowly obconic, 8–15 mm long, constricted at top of ovary and flared slightly at summit, 1.5–2 mm diameter at base, 3–4 mm diameter at top, greenish lavender or whitish, usually glabrous externally but sometimes with few scattered hairs, the lobes 5(4), rounded to oval or lanceolate, 2–4 mm long, spreading, densely ciliate-lanate with branched hairs which are apparent to the naked eye as a tiny white fringe; stamens unequal to subequal, usually exserted; filaments adnate to about the middle of the corolla-tube, from rather densely to sparsely hairy on basal 1.5 mm of their free portion, adjacent corolla-tube also hairy; style longer than the stamens, usually exserted 2–3 mm. FRUITS ovoid, 6–12 mm long, bright red, 8–30-seeded (Fig. 2H). n = 12. —River bottoms and alluvial flats in deserts of the Southwest (Fig. 3B): Coconino, Maricopa, Mohave, Pima, Pinal, Yuma cos. (Fig. 1I); 50–1000 m (100–3300 ft); Mar–May; s CA to TX, NV, UT; n Mex.

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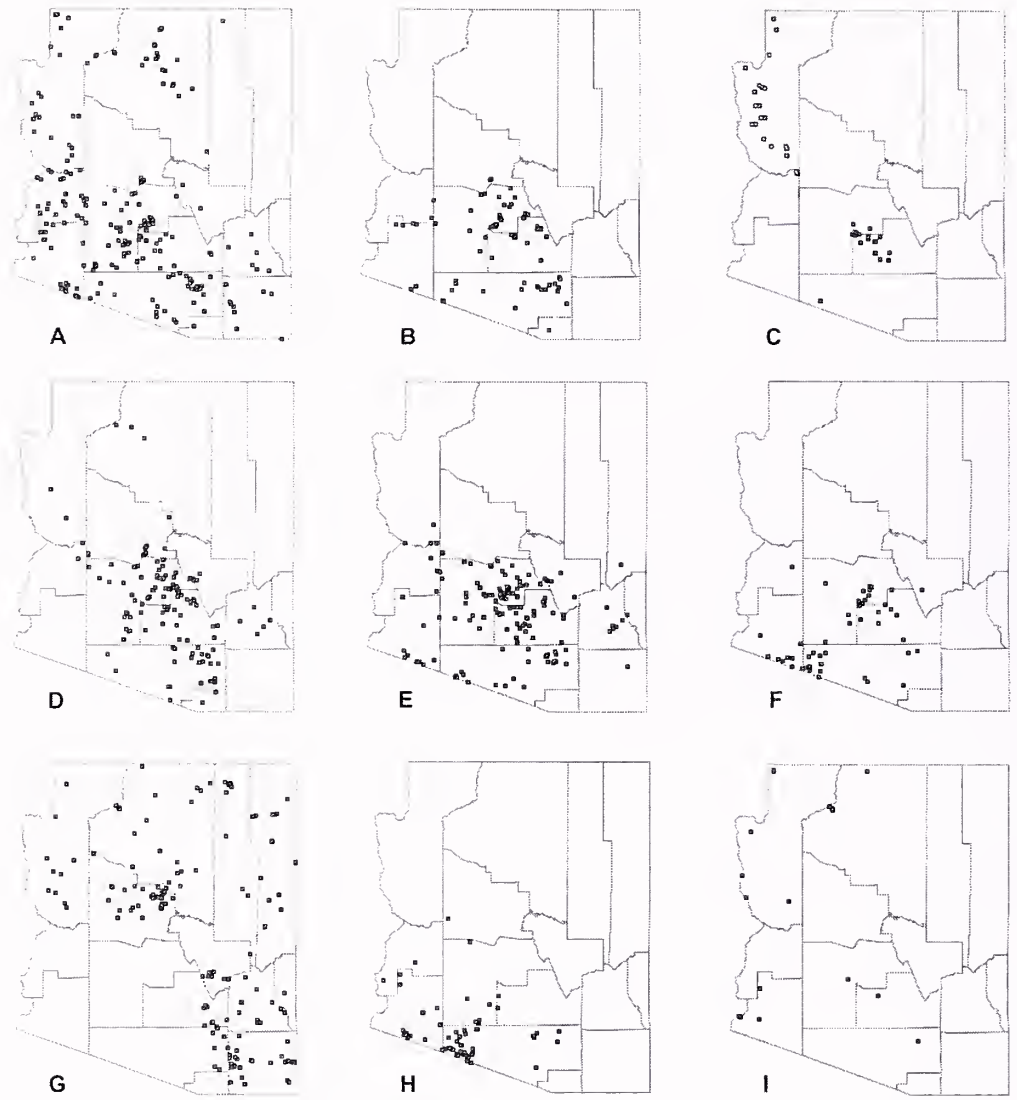
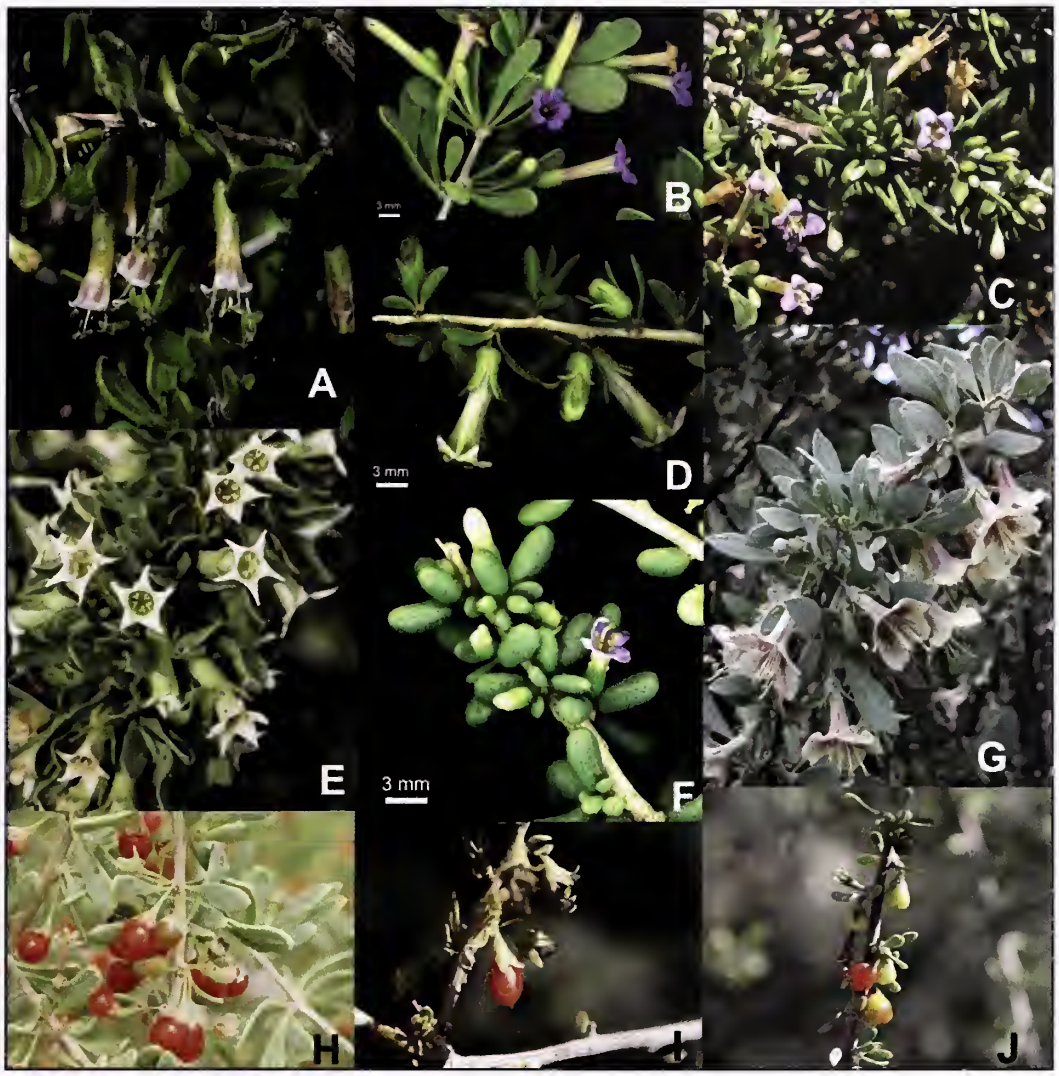


Solanaceae Figure 1. Distributions of: (A) *Lycium andersonii*; (B) *Lycium berlandieri*; (C) *Lycium californicum* (closed squares in sc AZ), *Lycium cooperi* (open squares in nw AZ): (D) *Lycium exsertum*; (E) *Lycium fremontii*; (F) *Lycium macrodon*; (G) *Lycium pallidum*; (H) *Lycium prishii*; (I) *Lycium torreyi*.



Solanaceae Figure 2. *Lycium* flowers and fruits: (A) *L. exsertum* (photo by E. Makings); (B) *L. fremontii*; (C) *L. andersonii*; (D) *L. macrodon*; (E) *L. cooperi*; (F) *L. californicum*; (G) *L. pallidum* (photo by M. Licher); (H) *L. torreyi*; (I) *L. parishii*; (J) *L. berlandieri* - (all photos by L. R. Landrum unless otherwise indicated).

Solonaceae Figure 3. Habitats of *Lycium*: (A) *L. californicum* near Casa Grande; (B) *L. torreyi* in a flood plain of the Colorado River near Bullhead City.

ISOËTACEAE QUILLWORT FAMILY

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Perennial herbs, heterosporous. ROOTS adventitious, arising from between the stem lobes, unbranched or branched. STEMS usually 2-lobed, stout, short, fleshy, cormlike, with reduced internodes, lobed. LEAVES usually numerous, deciduous, appearing tufted, linear, tapered to the sharply pointed tip, glabrous, hollow (with 4 longitudinal chambers) with a single midvein, the base broadened and convex (spoon-shaped), bearing 1 sporangium in a shallow pit on the adaxial (inner) side and a thin scale (ligule) adjacent and distal to the sporangium. SPORANGIA of 2 types, usually on the same plant, thin-walled, lacking an annulus, breaking open irregularly through decay, partially covered along the margin by a flap of tissue (velum), some with numerous megaspores, others with numerous microspores. MEGASPORANGIA with 50–300 megaspores. MEGASPORES relatively large, much bigger than the dust-like microspores, trilete, globose. MICROSPORANGIA with 150,000 or more microspores. MICROSPORES monolete, bean-shaped. GAMETOPHYTES reduced, developing inside the spores, the archegonia and antheridia protruding from the spore wall. —1 genus, ca. 150 spp., nearly worldwide.

Isoëtes L. Quillwort

Characters of the family. (Greek for "equal" and "year" [evergreen]).

Species of quillworts are often overlooked in the field, because of their superficial similarity to some aquatic species of grasses, sedges, and rushes.

Isoëtes bolanderi Engelm. (for Henry N. Bolander, American botanist). Bolander's Quillwort (Fig. 2). —Submerged aquatics. LEAVES 4.5–19(–24) cm long, usually somewhat stiff but flexible, tapered abruptly to the sharply pointed tip. SPORANGIA 4–12 mm long, ellipsoid, the wall often with fine brown-streaks. VELUM covering less than 1/2 of the sporangium. MEGASPORES 0.3–0.5 mm in diameter, white, rugulose or tuberculate. MICROSPORES 20–30 μm long, grayish

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brown, spinulose. $2n = 22$. —Ponds and lakes (Fig. 3): Apache, Cochise, and Coconino cos. (Fig. 1); 1900–2700 m (6000–8900 ft); Jul–Sep; WA to MT, s to CA, WY, and NM; w Can.

This species is quite uncommon in Arizona. Populations in a few ponds along the Mogollon Rim in Coconino County have not been seen in recent decades due to the lowering of the local water table, but the spores are long-lived and the species may reappear if conditions change. Plants in the Lukachukai Mountains of Apache County still appear relatively secure. The single historical specimen from the Huachuca Mountains originally was referred to var. *pygmaea* (Englem.) Clute, a small-leaved form not recognized by most current botanists. It has not been relocated in Cochise County in modern times.

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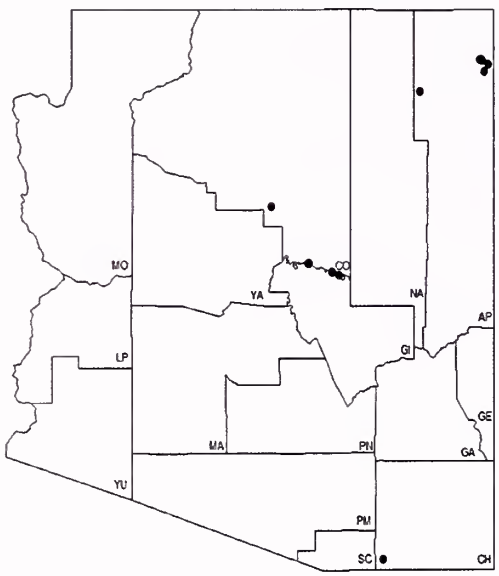

Isoëtaceae Figure 1. Distribution of: *Isoëtes bolanderi*

Isoëtaceae Figure 2. *Isoëtes bolanderi*, closeup of plant.

Isoëtaceae Figure 3. *Isoëtes bolanderi,* habitat in shallow water.

MARSILEACEAE CLOVER FERN FAMILY

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Perennial aquatic herbs, usually floating-leaved, sometimes stranded on mud, heterosporous. ROOTS adventitious, mostly appearing fascicled from the stem nodes, usually pinnately branched. RHIZOMES stoloniform, usually with several to numerous branches, long-creeping (shorter in terrestrial forms), terete, glabrous or with short appressed medially-attached hairs (in terrestrial forms). LEAVES alternate, 2-ranked, long-petiolate (this varying with water depth). BLADES palmately 4-foliate in ours, the leaflets wedge-shaped, lacking a costa, the venation forming numerous elongate simple areoles. SORI borne in sporocarps, these produced from the petiole base or the proximal portion of the petiole, solitary or in small loose clusters, the peduncles shorter than the petioles. SPOROCARPS of 1 type, oblong-oval to quadrangular or nearly circular in outline, mostly flattened, densely pilose with loose shaggy hairs when young, glabrescent with age, hard-walled, dehiscing along the rim, containing numerous sori of megasporangia and microsporangia, these attached to a hygroscopic gelatinous ring (sorophore). INDUSIA sac-like, membranous, ephemeral when hydrated. SPORANGIA membranous-walled, lacking an annulus, ephemeral once hydrated. MEGASPORES 1 per megasporangium, ovoid to globose, with a small hemispheric apical papilla, the surface smooth to faintly granulate, pale yellow to yellow. MICROSPORES 20–64 per microsporangium, trilete, globose, thin-walled, pale yellow. GAMETOPHYTES reduced, developing mostly inside the spores, the archegonia and antheridia protruding from the spore wall. —3 genera, ca. 55 spp., nearly worldwide.

The small genus, *Pilularia* A. Braun (6 species), is unique in the family in its subterranean nearly globose sporocarps and bladeless leaves (most easily recognized by their circinate vernation). The single North American species, *P. americana* A. Braun (American pillwort) is an inconspicuous plant easily overlooked by collectors. Its known distribution in the United States is widespread but quite sporadic, in part due to under collection, but also because of disjunct dispersal by migratory waterfowl. This species has been reported from southeastern California and should be searched for in Arizona. It is usually found among the emergent graminoid

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vegetation along the margins of ponds, ephemeral pools, and other bodies of still water.

Marsilea L. Clover Fern

Colonial aquatic perennial herbs. PETIOLES slender, lax in floating-leaved forms. LEAFLETS 4, wedge-shaped, sometimes with narrow brown or reddish brown lines or streaks along the veins. SPOROCARPS positioned aboveground (rarely subterranean elsewhere), oblong-oval to ovate or quadrangular in outline, flattened, attached laterally to the stalk tip, the stalk tip often extended past the attachment point as a low tubercle or tooth, in some species a second tooth produced along the acroscopic portion of the rim distal to the stalk tip, the surface with evident venation, tan to grayish brown or dark brown at maturity, dehiscing into 2 valves. X = 20. —Ca. 45 spp., nearly worldwide. (for Luigi Marsigli, Italian mycologist).

The sporocarps of *Marsilea* species, which have a long fossil history, also are extremely long-lived. Samples from century-old herbarium specimens have been germinated successfully in the laboratory. The life cycle is also completed extremely quickly (most ferns require several months), perhaps as an adaptation to fluctuating water levels, and less than a week usually is necessary following sporocarp germination for fertilization and the subsequent generation of new sporophytes.

Sporocarps are required for most species determinations in *Marsilea*. In the Arizona species, these tend to be produced only during the under collected "terrestrial phase" when plants stranded by receding waterlines produce stems with relatively closely spaced nodes and short-petiolate leaves. Thus, the distributions of the two species present in Arizona are not fully understood.

1. Sporocarps mostly 3–5 mm long, 2–3 mm wide, the tooth distal to the stalk tip absent or poorly developed, less than 0.2 mm long; leaflets symmetrically cuneate, the lateral margins relatively straight ..... ***M. mollis***
1' Sporocarps mostly 4–7 mm long, 3–6 mm wide, the tooth distal to the stalk tip well-developed, 0.4–1.2 mm long; leaflets often slightly asymmetrically cuneate, with 1 of the margins shallowly concave ..... ***M. vestita***

Marsilea mollis B. L. Rob. & Fernald (soft-hairy). Chihuahuan Water Clover. —PETIOLES 1–20 cm long, glabrous or sparsely appressed-hairy. LEAFLETS 4–17 mm long, broadly wedge-shaped, broadly rounded at the tips, symmetrically cuneate, sparsely pilose adaxially, moderately to densely pilose abaxially, the lateral margins straight or nearly so. SPOROCARPS solitary, appearing somewhat nodding, produced from the tip of short peduncle attached at or rarely just above the petiole base, (2.4–)3–5 mm long, 2–3 mm wide, oblong-ovate in outline, the tooth distal to the stalk tip, absent or less commonly poorly developed, less than 0.2 mm long, bluntly triangular (Fig. 2C). MEGASPORES 460–580 µm in diameter (excluding the apical papilla). MICROSPORES 60–80 µm in diameter. $2n = 40$. —Shallow water and margins of ponds, lakes, stock tanks, cienegas, and less commonly streams and marshy meadows: Coconino, Gila, Graham, Mohave, Navajo, Pima, Santa Cruz, Yavapai cos. (Fig. 1A); 1350–2250 m (4400–7400 ft); AZ, TX; s to Argentina.

Marsilea vestita Hook. & Grev. (clothed [hairy]). Hairy Water Clover (Fig. 2A). —PETIOLES 1–35 cm long, glabrous or sparsely appressed-hairy. LEAFLETS 5–22 mm long, wedge-shaped to broadly wedge-shaped, broadly rounded to nearly truncate at the tips, often slightly asymmetrically cuneate, glabrous to more commonly moderately pilose on both surfaces, the lateral margins straight or more commonly 1 margin shallowly concave. SPOROCARPS solitary, appearing more or less perpendicular to the peduncle produced from the tip of a short peduncle attached at or rarely just above the petiole base, (3.6–)4–7 mm long, 3–6 mm wide, oblong-quadrangular to broadly oval in outline, the tooth distal to the stalk tip well-developed, 0.4–1.2 mm long, sharply and narrowly triangular (Fig. 2B). MEGASPORES 450–515 µm in diameter (excluding the apical papilla). MICROSPORES 65–80 µm in diameter. $2n = 40$. [*M. fournieri* C. Chr., *M. mucronata* A. Braun, *M. tenuifolia* Engelm. ex A. Braun, *M. uncinata* A. Braun]. — Shallow water and margins of ponds, lakes, stock tanks, reservoirs, and streams: Cochise, Mohave, Pima, Pinal, Santa Cruz, Yuma cos. (Fig. 1B); 450–1650 m (1400–5400 ft); WA to MN, s to CA.

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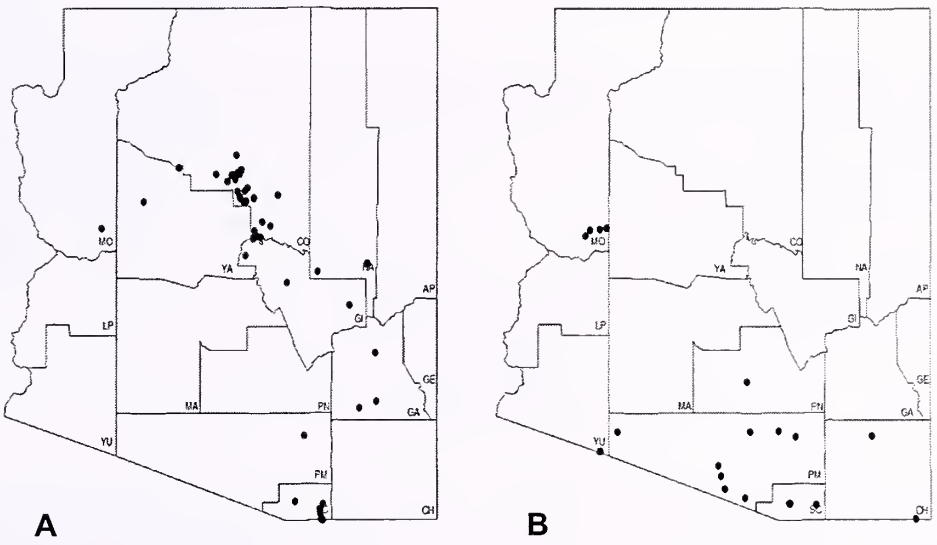
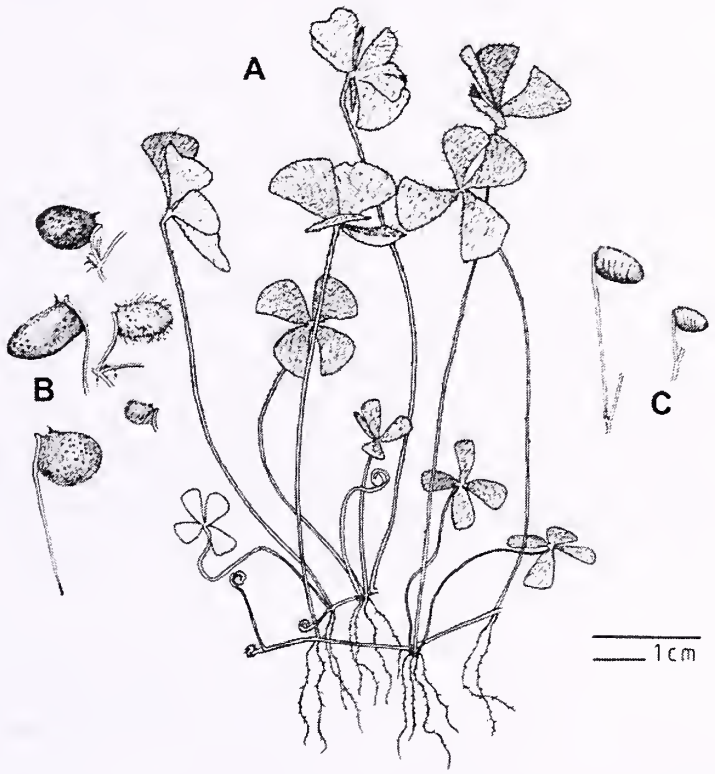


Marsileaceae Figure 1. Distribution of: (A) *Marsilea mollis*; (B) *Marsilea vestita.*



Marsileaceae Figure 2. *Marsilea*: (A) habit of *M. vestita*, plant from California; (B) five sporocarps of *M. vestita,* showing variation in size and in length of peduncle; (C) two sporocarps of *M. mollis* from the same collection, the larger from a plant in cultivation (scale bars: A short and B,C long) – (image: 'figure 17', in David M. Johnson. 1986, used with permission of the author).

POLYPODIACEAE POLYPODY FAMILY

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Perennial herbs with branched or unbranched rhizomes, these scaly and often pruinose or glaucous, the scales sometimes clathrate ("resembling latticework"). ROOTS adventitious, usually branched. AERIAL STEMS absent. LEAVES closely or widely spaced along the rhizome, often attached at a joint to a low peg-like protrusion of the rhizome (phyllopodium), ours monomorphic, the vernation circinate. PETIOLES with usually 3 small vascular bundles basally. BLADES pinnatisect in ours, usually at least somewhat coriaceous, distally usually somewhat pinnatifid. VENATION free or more commonly casually to regularly anastomosing, sometimes difficult to observe. SORI on the abaxial leaf surface, surficial or from shallow pits in the blade surface, often restricted to the distal half of the blade, discrete in ours, in a single row on each side of the costa in ours, circular to oblong-elliptic in outline. INDUSIA absent. PARAPHYSES sometimes present among the sporangia, peltate or clavate. SPORANGIA with a stalk 2 or 3 cells wide, the capsule with a vertical ring-like annulus. SPORES 64 per sporangium, monomorphic, monolete, bean-shaped, usually yellow. GAMETOPHYTES surficial, cordate, green, usually glabrous, potentially bisexual. —Ca. 40 genera and 500 spp., nearly worldwide.

The Polypodiaceae, which at one time were circumscribed to comprise most of the more advanced groups of ferns, are here treated in a more restricted sense. Generic classification within the family continues to undergo revision. The family is most diverse in the tropics, and is an important component of epiphytic vegetation in many forest types.

1. Scales of the abaxial leaf surface relatively conspicuous, scattered over the entire surface, peltate; developing sori with a dense covering of peltate scales, these shed as the sporangia mature ..... ***Pleopeltis***

1' Scales of the abaxial leaf surface inconspicuous, confined to the midrib and proximal portions of the costae, attached basally; developing sori naked ..... ***Polypodium***

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Pleopeltis Humb. & Bonpl. ex Willd. Scaly Polypody

RHIZOMES slender, short-creeping, not pruinose or glaucous, densely scaly, the scales strongly bicolorous, somewhat clathrate. LEAVES usually relatively widely spaced, evergreen, hygroscopic. PETIOLES mostly shorter than to about as long as the blade. BLADES leathery, the lobes linear-oblong, the margins entire or minutely crenate, glabrous adaxially, with conspicuous peltate scales scattered over the entire abaxial surface. VENATION with occasional simple areoles, difficult to observe. SORI surficial or from shallow pits in the blade surface, when young with a dense covering of ephemeral peltate scales similar to those of the blade surface. PARAPHYSES absent. SPORANGIA with the capsule nonglandular. —50 or more spp., New World, Afr., Asia. (Greek for "many" and "shield").

Until recently, *Pleopeltis* was restricted to a small group of mostly simple-leaved ferns. Phylogenetic research on the Polypodiaceae has indicated that most of the groups of New World polypodies with peltate leaf scales are more closely related to *Pleopeltis* than *Polypodium* sensu stricto and an expanded circumscription of the genus has become accepted by many pteridologists.

Pleopeltis riograndense (Wendt) E. G. Andrews & Windham (of the Rio Grande). Rio Grande Scaly Polypody. —RHIZOMES 2–3 mm in diameter, usually short-creeping, few-branched, the scales 2.5–3 mm long, subulate to lanceolate, acuminate at the tip, the central stripe dark brown with strongly clathrate cells, surrounded by light brown nonclathrate cells, the margins fimbriate-ciliate. LEAVES 3–20 cm long. PETIOLES longitudinally grooved adaxially, green, sometimes brown to purplish brown at the base, sparsely to moderately scaly, the scales grading from like those of the rhizome to those of the blade. BLADES 1–5 cm wide, oblong-triangular to ovate, with 2–10 lateral lobes, the proximal lobes appearing alternate along the midrib, the lobes 6–25 mm long, 2–8 mm wide, the abaxial scales 1–3 mm long, mostly narrowly ovate, more or less concolorous, reddish brown, clathrate, the margins fimbriate-ciliate. SPORES 60–74 μm long, the surface smooth with scattered globose deposits. $2n = 148$. [*Polypodium thyssanolepis* A. Braun ex Klotzsch var. *riograndense* Wendt]. —Shaded ledges and crevices of rock outcrops of canyons, usually on granite, quartzite, or rhyolite: Cochise, Pima, Santa Cruz cos. (Fig. 1A); 1250–2100 m (4100–6900 ft); AZ, TX; n Mex.

Earlier authors referred to this taxon as *Polypodium thyssanolepis*. That name (in the strict sense) refers to a Mexican species with leaves having sparser scales that are broadly ovate to nearly circular, more regularly areolate venation, and more or less opposite proximal lobes.

Polypodium L. Polypody

RHIZOMES slender to stout, short- to long-creeping, sometimes pruinose or glaucous, densely scaly, the scales concolorous to somewhat bicolorous, not clathrate. LEAVES usually relatively widely spaced, evergreen or deciduous

(drought-deciduous in Arizona species), not hygroscopic. PETIOLES mostly shorter than the blade. BLADES slightly thickened, the lobes linear-oblong to linear -triangular, the margins entire or minutely to shallowly crenate or serrate, glabrous or with sparse minute glandular and/or nonglandular trichomes adaxially, with sparse minute glandular trichomes and inconspicuous basally attached lanceolate scales along the midrib and proximal portions of the costae abaxially. VENATION free or with rare simple areoles, usually easily observed, at least in young leaves. SORI surficial, naked during development. PARAPHYSES absent in ours. SPORANGIA with the capsule nonglandular or rarely glandular. —Ca. 100 spp., nearly worldwide. (Greek for "many" and "little feet").

Reeves (1981) reported *P. glycyrrhiza* D. C. Eaton from a steep canyon in the Sierra Ancha (Gila County), but this population has since been described as *P.* ×*aztecum* Windham & Yatsk. (2005; Fig. 3), a novel sterile hybrid between *P. hesperium* and an as-yet unidentified second parent. This tetraploid ($2n$ = 148) hybrid differs markedly from *P. hesperium* in a number of features, including the following: RHIZOMES 4–9 mm in diameter, not or very slightly pruinose, the scales ovate with a deeply cordate base. LEAVES (7–)20–45 cm long, (3–)6–12 cm wide. BLADES with 8–34 lateral lobes, the midrib and lateral veins with scattered nonglandular trichomes adaxially. SPORANGIA frequently abortive, the capsules with conspicuous 2-celled glands. *Polypodium calirhiza* Whitmore & A.R. Sm. of California and Oregon (disjunct in central Mexico) has been suggested as a possible second parent, but presently this species is not known to grow anywhere in Arizona.

Polypodium hesperium Maxon (of the West). Western Polypody (Fig. 2). —RHIZOMES 2–6 mm in diameter, short- to long-creeping, few-branched, sometimes pruinose, the scales 3–5 mm long, lanceolate, acuminate at the tip, truncate to slightly rounded at the base, usually concolorous but occasionally with a faint central stripe of darker nonclathrate cells, tan to brown, the margins entire or denticulate. LEAVES 3–25(–35) cm long. PETIOLES longitudinally grooved adaxially, green, sometimes brown to purplish brown at the base, with sparse minute glandular trichomes. BLADES 1.5–6.5 cm wide, oblong-triangular to narrowly ovate, with 3–16 lateral lobes, the proximal lobes appearing alternate or less commonly opposite along the midrib, the lobes 7–30 mm long, 2–12 mm wide, glabrous or with a few minute glandular trichomes along the midrib adaxially, with sparse minute glandular trichomes and inconspicuous basally attached lanceolate scales along the midrib and proximal portions of lateral veins abaxially. SPORES 58–75 μm long, the surface rugose or finely verrucose. $2n$ = 148. [*Polypodium vulgare* L. var. *hesperium* (Maxon) A. Nelson & J. F. Macbride, *P. vulgare* var. *columbianum* Gilbert, *P. vulgare* var. *perpusillum* Clute, *P. prolongilobum* Clute]. —Shaded ledges and crevices of rock outcrops of canyons, usually on igneous and volcanic substrates, but also on sandstone and rarely limestone: Cochise, Coconino, Gila, Graham, Pima, Yavapai cos. (Fig. 1B); 1500–3150 m (4920–10,350 ft); w U.S.; w Can.; nw Mex.

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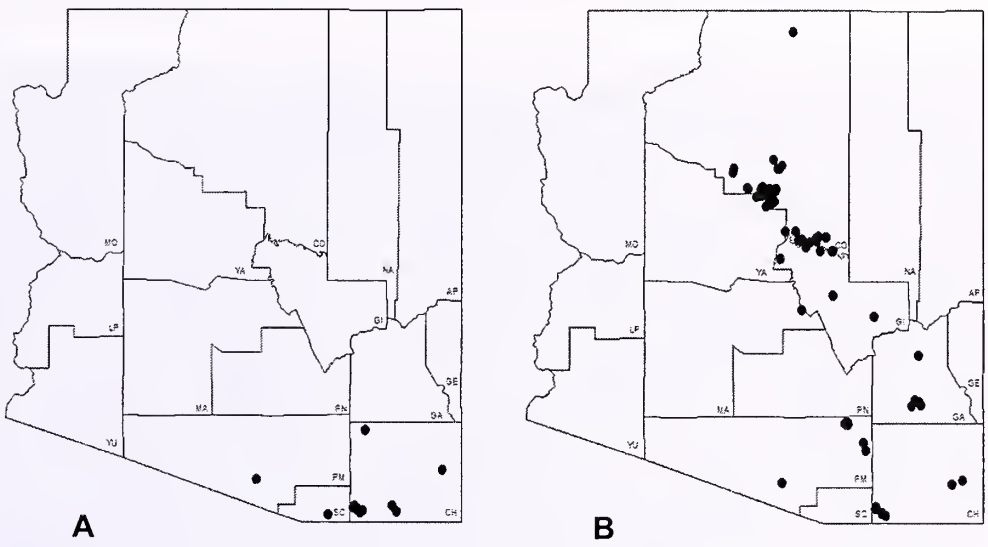
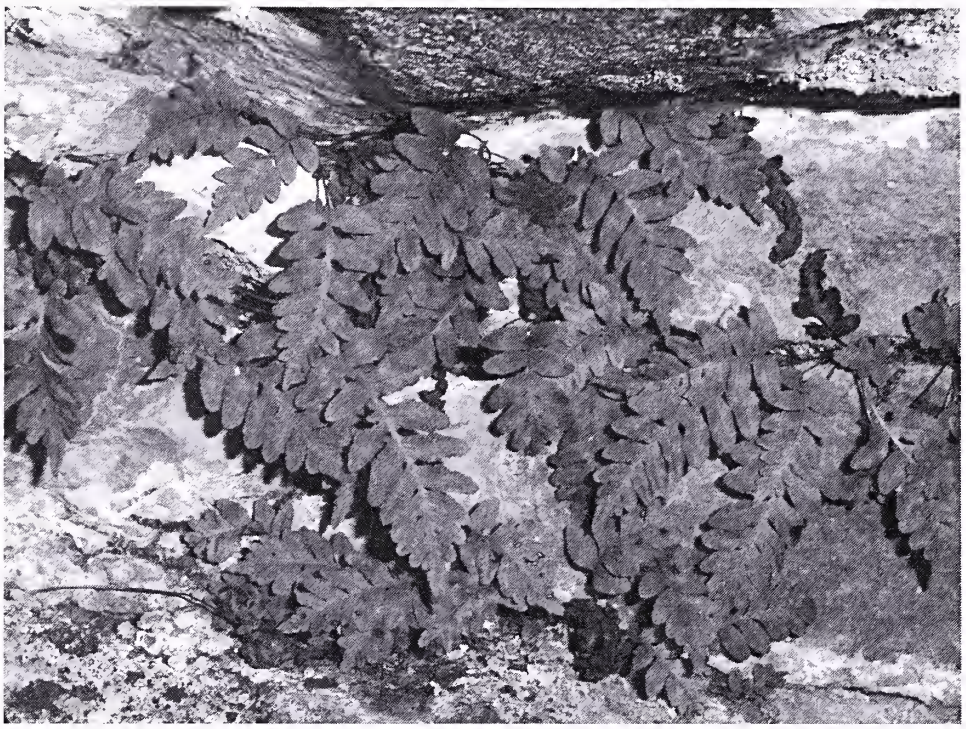


Polypodiaceae Figure 1. Distributions of: (A) *Pleopeltis riograndense* (B) *Polypodium hesperium*.



Polypodiaceae Figure 2. *Polypodium hersperium,* closeup of plant.

Polypodiaceae Figure 3. *Polypodium* ×*aztecum*, a sterile hybrid between *P. hesperium* and an as-yet unidentified second parent.

SELAGINELLACEAE SPIKEMOSS FAMILY

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Perennial herbs in ours with often dichotomously branched stems. ROOTS adventitious, short, produced from near the tips of modified leafless root-like stems (rhizophores), branched or more commonly unbranched. LEAVES variously arranged, scale-like, with the venation restricted to a midvein. SPORANGIA of two types, kidney-shaped to depressed-ovoid, positioned on the adaxial base of leaf-like sporophylls, arranged in strobili terminal on the branches. MEGASPORANGIA with usually 4 megaspores, these relatively large, trilete, tetrahedral-globose. MICROSPORANGIA with numerous microspores, these minute, trilete, tetrahedral-globose. GAMETOPHYTES reduced, developing mostly inside the spores, the archegonia and antheridia protruding from the spore wall. —1 genus, 700–750 spp., nearly worldwide.

Selaginella P. Beauv. Spikemoss

STEMS (except in *S. rupincola*) not differentiated into rhizomes and aerial stems, branching dichotomously or more commonly pinnately, the branches sometimes dichotomously forked. RHIZOPHORES produced from leaf axils on the adaxial side of the stem, elongate, slender, white to more frequently dark brown. LEAVES sometimes dimorphic (those on the abaxial stem side sometimes larger and gray to tan or brown), appearing densely spirally arranged, narrowly elliptic to ovate, papery to somewhat hardened, tapered at the tip, the midvein usually noticeably ridged, sometimes extended into an awn-like or hair-like appendage (seta), the margins variously entire to ciliate. STROBILI solitary on the branch tips, 4-ranked, the sporophylls differentiated from vegetative leaves, usually somewhat keeled and strongly folded around the sporangia, often slightly auriculate at the base. MEGASPORES 0.2–1.3 mm in diameter. MICROSPORES 30–75 mm in diameter. —700–750 species, nearly worldwide. (Diminutive form of ancient name "Selago" for a kind of club-moss [small *Lycopodium*]).

The above description applies primarily to species of *Selaginella* subg. *Tetragonostachys* Jermy (ca. 50 species), to which all of the Arizona species belong. Taxa in this subgenus often are relatively difficult to determine, differing in small structural details. All of the Arizona taxa are hygroscopic, but some species, like *S. arizonica* and *S. eremophila*, have branch tips that curl inward with drought, whereas in others the leaves merely become more appressed and duller gray to

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brown. Terminal setae are best observed on leaves near the tips of vegetative branches on newer growth.

Of the 5 currently accepted subgenera, 2 others occur in temperate North America. Subgenus *Selaginella* comprises only 2 species of northern North America and Hawaii that resemble certain kinds of diminutive clubmosses. The resurrection plants are a small group presently classified in the large, mostly tropical subg. *Stachygynandrum* (P. Beauv.) Baker, which is considered polyphyletic by some pteridologists (Korall & Kenrick 2002). There are persistent anecdotal reports that one of these species grows somewhere in southeastern most Arizona, but this has not been confirmed to date. The resurrection plants have the main stems densely cespitose and forming a dense rosette that curls inward during times of drought. Rhizophores are restricted to the basal portions of the stems. Two mainly Mexican species, *S. lepidophylla* (Hook. & Grev.) Spring and *S. pilifera* A. Braun, are found in southern New Mexico and adjacent Texas, and a third, *S. novoleonensis* Hieron., occurs from the mountains of central Sonora eastward. These should be searched for in eastern Cochise County on rocky slopes and exposed canyon walls.

1. Stems dimorphic, differentiated into a rhizomatous, prostrate main stem system (this sometimes subterranean) with shorter leaves and aerial branches, these elongate, procumbent or more commonly ascending to erect, with longer leaves, with rhizophores produced only below the midpoint; leaves grayish green ..... ***S. rupincola***

1' Stems monomorphic, not differentiated into rhizomatous and aerial portions (very short ascending branches present in some species), prostrate to decumbent or uncommonly procumbent; rhizophores produced more or less throughout, at least on the main stems; at least the adaxial leaves green to dark, olive, or yellowish green when hydrated 2

2. Leaves slightly to strongly dimorphic, those on the abaxial stem side somewhat larger, decurrent at the base, somewhat chaffy or hardened, and persistently gray to tan or brown, those on the adaxial stem side somewhat smaller, adnate to the stem, herbaceous to somewhat papery or leathery, green when hydrated 3

3. Leaves slightly dimorphic; ends of branches appearing relatively straight when dried ..... ***S. densa***

3' Leaves relatively strongly dimorphic; ends of branches appearing curled when dried 4

4. Leaves on adaxial side of stem 1.9–2.3 mm long; setae 0.1–0.3 mm long, relatively stout and straight, frequently persistent on at least some of the mature leaves (but most easily observed at the branch tips) ..... ***S. arizonica***

4' Leaves on adaxial side of stem 1.3–1.5 mm long; setae 0.3–0.4 mm long, relatively slender and contorted, usually shed as the leaves develop (visible only at the developing branch tips) ..... ***S. eremophila***

2' Leaves monomorphic, those of the abaxial and adaxial stem sides similar in size, color, and texture 5

5. Both abaxial and adaxial leaves adnate (not decurrent) at the base, abruptly differentiated in color from the stems ..... ***S. mutica***

5' Leaves of at least the main stems decurrent at the base, not distinet in color from the stems 6

6. Lateral branches mostly elongate, prostrate to loosely spreading, the plants usually forming loose mats ..... ***S. underwoodii***
6' Lateral branches short, ascending, the plants forming dense low cushion-like mats 7
7. Dry stems not or rarely fragmenting ..... ***S. leucobryoides***
7' Dry stems readily fragmenting ..... ***S. watsonii***

Selaginella arizonica Maxon (of Arizona; Fig. 2). Arizona Spikemoss. —STEMS monomorphic, not readily fragmenting when dry, the branch tips appearing more or less curled when dry, prostrate, usually forming small loose low mats. RHIZOPHORES produced throughout. LEAVES relatively strongly dimorphic, the tip sharply pointed, with a stiff straight white glabrous seta 0.1–0.3 mm long (theis sometimes breaking off with age), the margins ciliate; those of the adaxial stem side 1.9–2.3 mm long, narrowly lanceolate, green to yellowish green when hydrated, the base abruptly adnate (differing in color from the stem); those of the abaxial stem surface 2.0–2.5 mm long, lanceolate to narrowly lanceolate, persistently gray to brown, the base decurrent (similar in color to the stem). STROBILI 4–10 mm long, the sporophylls ovate-deltate, narrowed to an acute tip lacking a seta, the margins denticulate to short-ciliate. MEGASPORES finely and often faintly rugose-reticulate, orange or yellow. —Rock ledges, cliffs, and open gravelly to rocky areas, usually on igneous or volcanic substrates or on sandstone: Gila, Graham, Maricopa, Pima, Pinal, Yavapai cos. (Fig. 1A); 600–1700 m (2000–5600 ft); AZ, TX; nw Mex.

The taxonomy of *S. arizonica* is still not fully understood. In the desert mountains of western Pima County uncommon apparent hybrids occur between *S. arizonica* and the closely related *S. eremophila*. Some of these putative hybrids are sterile with abortive spores, but other plants intermediate for one or more morphological traits produce apparently well-formed spores that are slightly larger than those of either of the parents. These may represent an allopolyploid that should be recognized taxonomically. Where *S. arizonica* co-occurs with the morphologically distinctive *S. rupincola*, occasional putative hybrids also are encountered with intermediate morphology and abortive spores.

Selaginella densa Rydb. (dense). Rocky Mountain Spikemoss. —STEMS monomorphic, not readily fragmenting when dry, the branch tips appearing straight when dry, prostrate, forming small, low, loose or dense cushion-like mats. RHIZOPHORES produced throughout. LEAVES slightly dimorphic, 2.5–5.0 mm long, (adaxial leaves sometimes slightly shorter than the abaxial leaves), linear to narrowly lanceolate, green to dark green when hydrated (adaxial leaves often persistently tan to brownish-tinged), the base decurrent (similar in color to the stem) and somewhat oblique, the tip with a straight or somewhat curved white seta 0.4–1.9 mm long (often breaking off with age), the margins ciliate. STROBILI 1–3 mm long, the sporophylls broadly lanceolate to ovate, narrowed to an acute tip with or without a seta, the margins entirely ciliate or denticulate distally. MEGASPORES usually relatively coarsely rugose-reticulate, orange. —3 vars.; w U.S. e to ND and TX, AK; Can.

1. Leaf margins relatively long-cilate, the terminal seta 1.2–1.9 mm long, moderately puberulent; sporophyll margins ciliate ..... var. ***densa***
1' Leaf margins relatively short-cilate, the terminal seta 0.4–1.2 mm long, glabrous, sparsely denticulate, or sparsely puberulent; sporophyll margins ciliate proximally grading to denticulate distally ..... var. ***scopulorum***

Var. **densa** (dense; Fig. 4). —LEAVES 2.5–5.0 mm long, the margins relatively long-cilate, the cilia 0.07–0.20 mm long, the tip with a seta 1.2–1.9 mm long, this moderately puberulent. SPOROPHYLLS with the margins ciliate their entire length, the tip usually with a well-differentiated seta. —Exposed rock ledges and rock outcrops in high mountains on volcanic substrates: Apache Co. (Fig. 1B); 2650–3500 m (8700–11,500 ft); ID to ND s to AZ and NM; Can.

Var. **scopulorum** (Maxon) R. M. Tryon (of the Rocky Mountains). —LEAVES 2.5–4.5 mm long, the margins relatively short-cilate, cilia 0.02–0.07 mm long, the tip lacking a seta or with a seta 0.4–1.2 mm long, this glabrous, sparsely denticulate, or sparsely puberulent. SPOROPHYLLS with the margins ciliate proximally grading to denticulate distally, the tip lacking a seta or with a short poorly differentiated seta. [*S. scopulorum* Maxon]. —Exposed rock ledges and rock outcrops in high mountains on volcanic substrates: Apache Co. (Fig. 1B); 3250–3500 m (10,650–11,500 ft); WA to MN s to n CA, AZ, and NM; w Can.

Some botanists consider this taxon to represent a separate species. However, Tryon (1955) indicated that some plants at the summit of Mt. Baldy, are somewhat intermediate in morphology with var. *densa*. The situation requires more detailed biosystematic study.

Selaginella eremophila Maxon (desert-loving). Desert Spikemoss. —STEMS monomorphic, not readily fragmenting when dry, the branch tips appearing curled when dry, prostrate, usually forming small loose low mats. RHIZOPHORES produced throughout. LEAVES relatively strongly dimorphic, the tip sharply pointed (Fig. 3), with a delicate contorted white seta 0.3–0.4 mm long (this often breaking off with age), the margins ciliate; adaxial stem leaves 1.3–1.5 mm long, lanceolate, green to yellowish green when hydrated, the base abruptly adnate (differing in color from the stem); abaxial stem leaves 2.0–2.7 mm long, lanceolate to elliptic-lanceolate, persistently gray to brown, the base decurrent (similar in color to the stem). STROBILI 3–8 mm long, the sporophylls ovate-deltate, narrowed to an acute tip lacking a seta, the margins short-ciliate. MEGASPORES with the surface, finely rugose-reticulate, light yellow. —Rock ledges, cliffs, and open gravelly to rocky areas, usually on igneous or volcanic substrates: Maricopa, Pima, Yuma cos. (Fig. 1C); 150–800 m (500–2600 ft); endemic to the Sonoran Desert region of s CA, s AZ, nw Mex.

The distribution of *S. eremophila* in Arizona is somewhat broader than was known to Tryon (1955) and Morton (1960), who knew the species in the state only from Yuma County. The easily abscised setae make some specimens difficult to distinguish from the closely related *S. arizonica*. See the treatment of that species for a discussion of possible hybridization between it and *S. eremophila*.

Selaginella leucobryoides Maxon (like *Leucobryum*, a moss genus). Mohave Spikemoss. —STEMS monomorphic or slightly dimorphic, the main stem prostrate, with short ascending branches, readily fragmenting when dry, the branch tips appearing straight when dry, forming small, low, dense cushion-like mats. RHIZOPHORES produced throughout. LEAVES monomorphic, 2.0–4.5 mm long, linear to narrowly oblong-lanceolate, green to dark green when hydrated, the base decurrent (similar in color to the stem) and more or less symmetrically narrowed, the tip narrowly pointed, sometimes with a straight or somewhat curved white seta 0.2–0.5 mm long (often breaking off with age), this denticulate, the margins relatively short-ciliate, sometimes grading to denticulate distally. STROBILI 4–15 mm long, the sporophylls broadly lanceolate to ovate-deltate, narrowed to an acute tip with a short seta, the margins denticulate, sometimes short-ciliate proximally. MEGASPORES smooth to finely rugose-reticulate, orange. —Rock outcrops, ledges, and cliffs, on limestone: Coconino, Mohave cos. (Fig. 1D); 600–1300 m (2000–4300 ft); nw AZ and adjacent s NV and e CA.

Selaginella mutica D. C. Eaton ex Underw. (blunt). —STEMS monomorphic, the main stem prostrate, with prostrate to loosely ascending branches, not readily fragmenting when dry, the branch tips appearing straight when dry, forming loose mats. RHIZOPHORES produced throughout. LEAVES monomorphic, 1–2 mm long, narrowly lanceolate to narrowly elliptic-lanceolate, green to dark green when hydrated, the base adnate (differing in color from the stem) and more or less symmetrically rounded or narrowed, the tip bluntly or sharply pointed, with or without a seta, the margins short- to long-ciliate, sometimes mostly denticulate. STROBILI 6–25 mm long, the sporophylls narrowly ovate to elliptic-ovate or ovate-deltate, narrowed to a blunt or sharply pointed tip with or without a short seta, the margins denticulate to ciliate. MEGASPORES finely to relatively coarsely rugose-reticulate, orange. —2 vars.; WY s to AZ and TX.

1. Leaves and sporophylls with the margins denticulate to irregularly short-ciliate, the teeth or hairs ascending; leaf tip with a well-defined, short seta 0.2–0.5 mm long ..... var. ***limitanea***
1'. Leaves and sporophylls with the margins usually relatively long-ciliate, the hairs spreading; leaf tip without a seta or with a minute, poorly differentiated seta to 0.06 mm long ..... var. ***mutica***

Var. **limitanea** Weath. (bordered). —LEAVES with the margins denticulate to irregularly short-ciliate, the teeth or hairs ascending, the tip sharply pointed, with a well developed seta, this 0.2–0.5 mm long, straight or somewhat curved, white or milky white. SPOROPHYLLS with the margins denticulate to irregularly short-ciliate, the teeth or hairs ascending. —Rock ledges and cliffs: Cochise co. (Fig. 1E; known from a single historical collection: *Ferris s.n., Paradise, AZ, March 1904*, GH); ca. 1700 m (5600 ft); se AZ to sw TX.

Var. **mutica** (blunt). —LEAVES with the margins usually relatively long-ciliate, the hairs spreading, the tip bluntly or sharply pointed, with a minute poorly

differentiated seta, this 0.03–0.06 mm long, straight, yellowish green. SPOROPHYLLS with the margins usually relatively long-ciliate (rarely denticulate elsewhere), the hairs spreading. $2n = 18$. —Rock outcrops, ledges, boulders, and cliffs, on various substrates: Cochise and disjunctly Apache, Coconino, Navajo cos. (Fig. 1E); ca. 1400–2600 m (4600–8500 ft); WY to AZ and sw TX.

Selaginella rupincola Underw. (rock-loving; Fig. 5). —STEMS dimorphic, not readily fragmenting when dry, the branch tips appearing straight when dry, forming loose low clumps, differentiated into a rhizomatous, prostrate, main stem system with elongated procumbent or more commonly ascending to erect main branches, some of the basal branches of the aerial stems (and rhizomes) remaining bud-like and not elongating. RHIZOPHORES of the aerial stems produced only below the midpoint. LEAVES dimorphic, those of the rhizomes 1.5–2.5 mm long, ovate to narrowly ovate, persistently gray to tan, the midvein slightly ridged, the base more or less adnate (not strongly different in color to the stem), the tip sharply pointed, without a seta, the margins denticulate to nearly entire; aerial stem leaves 3.0–4.7 mm long, narrowly elliptic-lanceolate to linear-lanceolate, light grayish green, the minutely puberulent base adnate (different in color from the stem) and rounded, the tip sharply pointed, with a white to pale yellow seta 0.7–1.8 mm long, this often bent outward, denticulate, the margins relatively long-ciliate, the cilia spreading. STROBILI 5–30 mm long, the sporophylls lanceolate, tapered to an acute tip, with a well-developed seta, the margins short-ciliate. MEGASPORES finely rugose to rugose-reticulate, orange. —Rock ledges, cliffs, and open gravelly to rocky areas, usually on igneous or volcanic substrates or on sandstone: Cochise, Gila, Pima, Pinal, Santa Cruz cos. (Fig. 1F); 900–1850 m (3000–6000 ft); s AZ to s TX; Mex.

For a discussion of possible hybridization with *S. arizonica*, see the treatment of that species. Tryon (1955) discussed the sporadic distribution in southern Arizona, New Mexico, and Texas of the rare *S.* ×*neomexicana* Maxon, which he thought to represent a sterile hybrid between *S. rupincola* and *S. mutica*, citing a single historical Arizona collection (*Ferris s.n., March 1904*, GH, US) from near Paradise (Cochise County). Aside from its abortive spores, this taxon closely resembles *S. rupincola*, but has leaves with shorter setae and the margins denticulate distally and with short ascending ciliation proximally. Valdespino (1993) suggested that more detailed biosystematic research is necessary to confirm the parentage of this putative hybrid. The report of *S.* ×*neomexicana* from Graham County by Buegge (2001) was based upon a misdetermined specimen of *S. rupincola*.

Selaginella underwoodii Hieron. (for Lucius M. Underwood, American botanist). Underwood's Spikemoss. —STEMS monomorphic, prostrate to loosely ascending, occasionally pendant, not readily fragmenting when dry, the branch tips appearing straight when dry, forming usually loose mats. RHIZOPHORES produced throughout. LEAVES monomorphic, 2.0–3.5 mm long, linear to narrowly triangular-lanceolate, green to dark green when hydrated, the base more or less decurrent (similar in color to the stem) and more or less symmetrically narrowed, the tip with a straight or somewhat curved yellowish green seta 0.2–0.8(–1.2) mm long

(sometimes breaking off with age), the margins short-ciliate, sometimes grading to denticulate distally. STROBILI 5–30 mm long, the sporophylls lanceolate to broadly lanceolate with a strongly auriculate base, narrowed to an acute tip with a short seta, the margins denticulate, sometimes grading to short-ciliate proximally. MEGASPORES finely rugose-reticulate, orange. [*S. underwoodii* var. *dolichotricha* Weath.]. —Rock outcrops, ledges, boulders, and cliffs, on various substrates: Cochise, Coconino, Gila, Graham, Pima, Santa Cruz, Yavapai cos. (Fig. 1G); 1500–2450 m (5000–8000 ft); UT and s CO s to AZ and TX; n Mex.

Selaginella watsonii Underw. (for Sereno Watson, American botanist). Watson's Spikemoss. —STEMS monomorphic, prostrate, not readily fragmenting when dry, the branch tips appearing straight when dry, forming dense usually cushion-like mats. RHIZOPHORES produced throughout. LEAVES monomorphic, 2.5–4.0 mm long, narrowly lanceolate, green to yellowish green when hydrated, the base more or less decurrent (similar in color to the stem) and more or less symmetrically narrowed, the tip with a straight or somewhat curved white seta 0.2–0.5 mm long (sometimes breaking off with age), the margins entire, denticulate, or short-ciliate. STROBILI 5–30 mm long, the sporophylls lanceolate to broadly lanceolate, narrowed to an acute tip with a short seta, the margins entire or denticulate. MEGASPORES finely rugose to rugose-reticulate, orange. —Rock outcrops, ledges, boulders, cliffs, and rarely on open gravelly slopes, on igneous and volcanic substrates and sandstone: Coconino, Mohave cos. (Fig. 1H); 2400–2550 m (7850–8400 ft); e WA s to e CA, e to MT and AZ.

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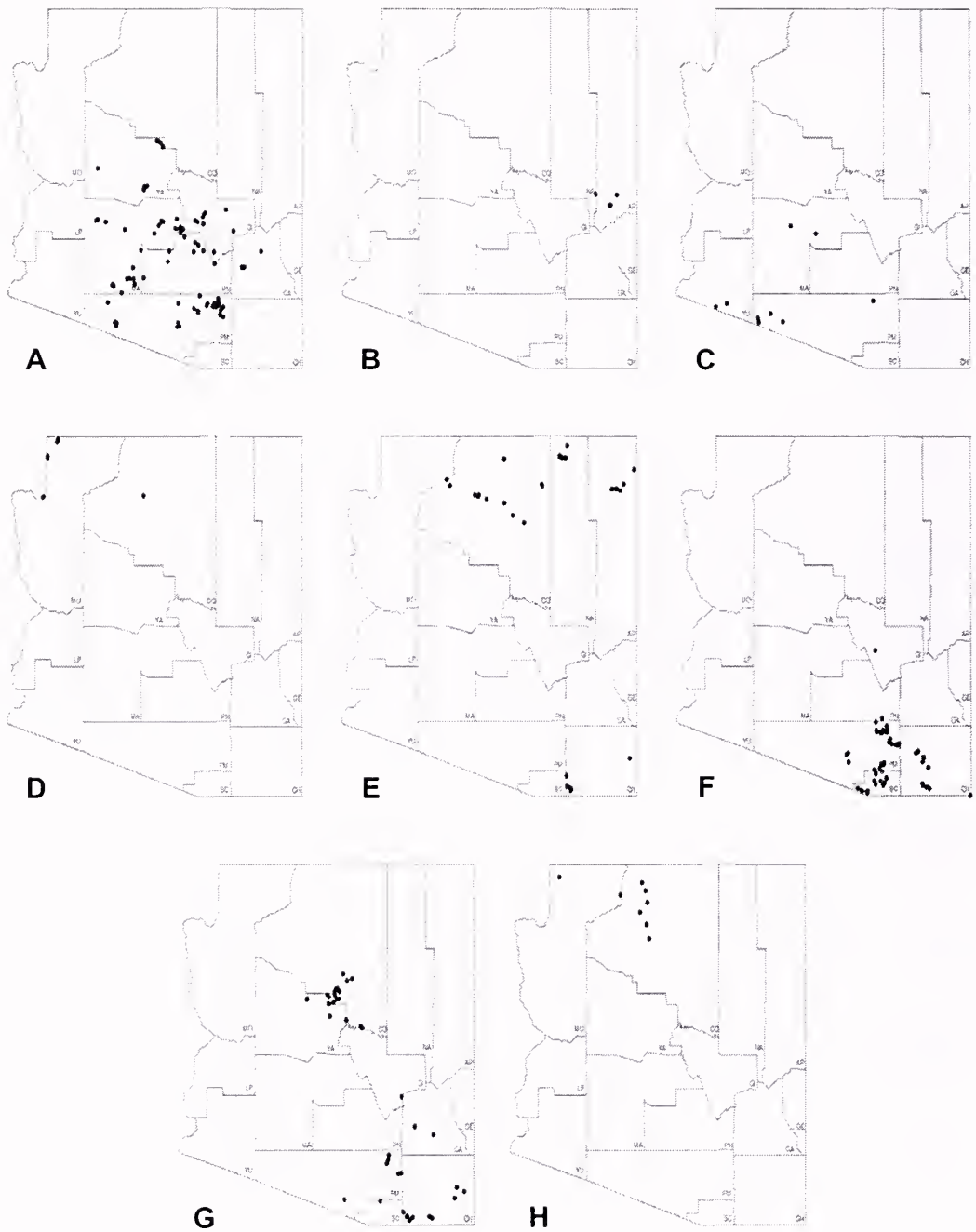

Selaginellaceae Figure 1. Distributions of: (A) *Selaginella arizonica*; (B) *Selaginella densa*; (C) *Selaginella eremophila*; (D) *Selaginella leucobryoides*; (E) *Selaginella mutica*; (F) *Selaginella rupincola*; (G) *Selaginella underwoodii*; (H) *Selaginella watsonii*.

Selaginellaceae Figure 2. *Selaginella arizonica,* habit.

Selaginellaceae Figure 3. *Selaginella eremophila*, close-up.

Selaginellaceae Figure 4. *Selaginella densa var. densa*, habit.

Selaginellaceae Figure 5. *Selaginella rupincola*, habit.

THELYPTERIDACEAE MARSH FERN FAMILY

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Perennial herbs with branched or unbranched rhizomes, these scaly, the scales not to somewhat clathrate ("resembling latticework"). ROOTS adventitious, usually branched. AERIAL STEMS absent. LEAVES closely or widely spaced along the rhizome, monomorphic in ours, the vernation circinate. BLADES variously pinnately compound, usually herbaceous in texture, the pubescence various but at least in part of short bristly needle-like hairs. VENATION free or anastomosing, commonly with opposing veinlets fusing into 1 or more chevron-like areoles below the sinus between 2 adjacent pinna lobes, the veinlets usually unbranched. SORI on the abaxial leaf surface, surficial, discrete, positioned along the veinlets on either side of the costules, circular in outline in ours. INDUSIA circular-reniform in ours, pseudopeltate (attached at the notch). PARAPHYSES absent or if present attached to the sporangial stalks, club-shaped. SPORANGIA with a stalk usually 3 cells wide, with a vertical ring-like annulus. SPORES usually 64 per sporangium, monomorphic, monolete, bean-shaped, usually brown. GAMETOPHYTES surficial, cordate, green, often hairy or glandular, potentially bisexual. —1–30 genera, ca. 900 spp., nearly worldwide.

Generic delimitation in the *Thelypteridaceae* has remained controversial, with most American authors lumping all of the species into a single genus, *Thelypteris*, and most authors working in the Old World splitting the family into about 30 genera. More recently, compromise treatments have been advocated in which 3–6 main groups are recognized as genera. Regrettably, new combinations await publication for many species under these newer classifications.

Thelypteris Schmidel Marsh Fern

RHIZOMES slender to stout, short- to long-creeping, densely scaly toward the tip, the scales strongly bicolorous, somewhat clathrate. LEAVES closely to relatively widely spaced, evergreen in ours. PETIOLES shorter than to about as long as the blade, usually grooved adaxially. BLADES herbaceous to somewhat papery, ovate to ovate-triangular, pinnate-pinnatifid. PINNAE linear, acuminate at the tip, with numerous lobes, the margins otherwise entire, hairy, sometimes also

Vascular Plants of Arizona: Thelypteridaceae. *CANOTIA* 5 (1): 49–52, 2009.
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inconspicuously scaly. VENATION free or with opposing veinlets fusing into 1 or more chevron-like areoles below the sinus between 2 adjacent pinna lobes, sometimes meeting at the sinus. SORI positioned along the veinlets, appearing in ours as a single row on either side of the costules, circular in outline. INDUSIA circular-reniform in ours, often withering or shed prior to soral maturity. SPORANGIA with the capsule glabrous or pubescent with needle-like trichomes. X = 27–36 [X = 36 in the segregate *Cyclosorus*]. —860–900 spp., nearly worldwide. (Greek for "female" and "fern").

Thelypteris puberula (Baker) C. V. Morton (minutely hairy). —RHIZOMES 4–8 mm in diameter, short- to more commonly long-creeping, usually unbranched, the scales 3–7 mm long, lanceolate, acuminate at the tip, monomorphic, brown, the margins ciliate, the surface minutely hairy. LEAVES closely to relatively widely spaced, 50–130 cm long. PETIOLES longitudinally grooved adaxially, straw-colored, sparsely scaly toward the base, at least when young, the scales similar to those of the rhizome, sparsely to moderately pubescent distally with minute spreading needle-like hairs. RACHISES similar to petioles, moderately to densely hairy. BLADES 15–45 cm wide, triangular-ovate, with numerous lateral pinnae, the basal 1 or 2 pairs of pinnae slightly reduced, the pinnae evenly or more commonly abruptly reduced toward the elongate pinnatifid tip. PINNAE mostly 7–22 cm long, 10–22 mm wide, lobed 1/2–4/5 of the way to the costa, the acroscopic basal lobe of proximal pinnae often slightly longer than the adjacent lobes, the basiscopic basal lobe of distal pinnae often fused to the rachis, the costae and costules minutely hairy and with sparse minute scales abaxially (Fig. 2). LOBES with the margins often somewhat curled under, minutely hairy on both surfaces or the surface glabrous adaxially. SORI more or less medial. INDUSIA withering prior to soral maturity, densely pubescent with minute needle-like hairs. PARAPHYSES absent. SPORANGIA glabrous. SPORES 35–55 mm long, the surface rugose, dark brown. $2n = 144$. [*Thelypteris augescens* (Link) Munz & I. M. Johnst. var. *puberula* (Baker) C. Chr., *Christella puberula* (Baker) Á. Löve & D. Löve]. —2 vars., 1 in AZ.

This taxon has been treated variously as one of ca. 900 spp. of a broadly circumscribed *Thelypteris*, among the ca. 580 species of a broadly circumscribed *Cyclosorus* Link (but no combination is available there) when an intermediate number of genera are recognized, or one of 60 or more mostly Old World species of *Christella* Lév. in the most finely dissected classification.

Var. **sonorensis** A. R. Sm. (of Sonora; Fig. 3). Sonoran Maiden Fern. —Blades hairy adaxially. —Along streams and/or bases of boulders in mesic canyon bottoms: Gila, Mohave, Pima, Pinal, Yavapai cos. (Fig. 1); 800–1100 m (2700–3600 ft); CA, AZ; Mex.

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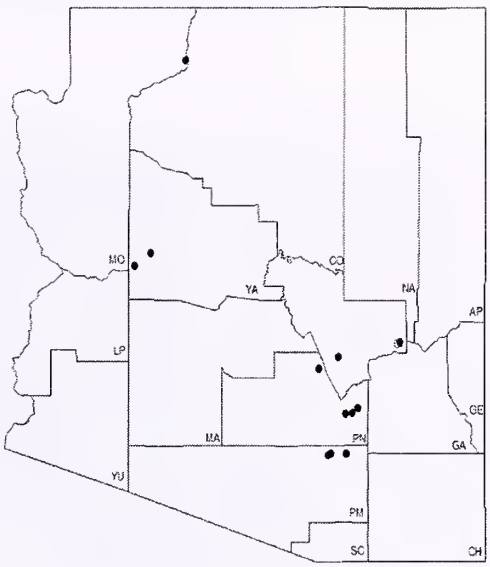
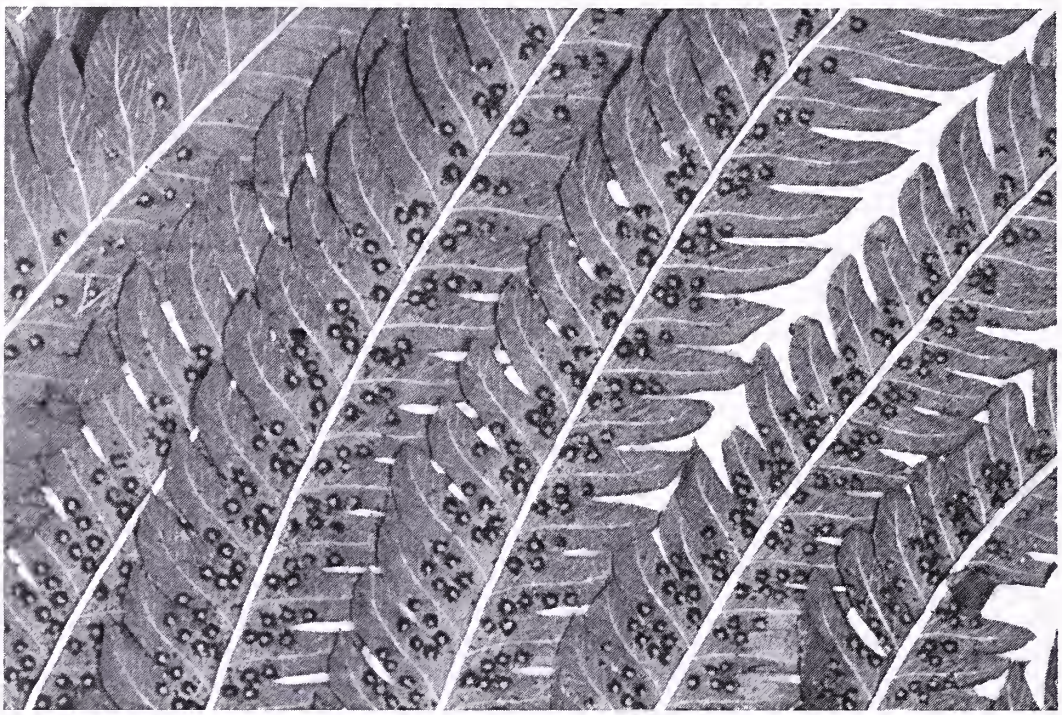


Thelypteridaceae Figure 1. Distributions of: *Thelypteris puberula* var. *sonorensis*



Thelypteridaceae Figure 2. *Thelypteris puberula* var. *sonorensis,* pinnae.

Thelypteridaceae Figure 3. *Thelypteris puberula* var. *sonorensis,* habit.

ELINOR LEHTO, ARIZONA BOTANIST, 1915–2009

Elizabeth Makings
Arizona State University Herbarium

On Sunday February 22, 2009 the botanical community lost a dear friend.

Elinor (Dixon) Lehto passed away at the Regional Medical Center in Richardson, Texas early Sunday morning, February 22, 2009 after a lengthy illness. Elinor was born in Dayton, Washington on 23 September, 1915 to Ott P. Dixon and Flora Ellen Keith. She was the oldest of four children. She received her elementary education in the Winona Public School and secondary education at the Endicott Union High School. She married Emil Lehto in March, 1939. The family moved from Washington to Arizona in 1960 and she entered Arizona State University in September, completing a Bachelor of Science degree in botany in 1966. She was Curator of the Herbarium, Botany Microbiology Department, Arizona State University on a half-time basis from 1962 to June 1966, and full-time staff from July 1966 to 1980. She completed the requirements for a Master of Science degree in biology in May of 1970. At ASU she was a member of Beta Beta Beta Biological Honor Society.

Elinor was the mother of three children – daughter Mary Lehto of Savannah, TX; son Stephen Lehto of Honolulu, HI; and was preceded in death by daughter Sylvia Stewart. She was divorced December 1966. She is also survived by one brother, Donald Dixon of Spokane, WA, two grandsons, and one great grandson.

Elinor lived a full life, spending her working years at Arizona State University as the Curator of the Herbarium. After retirement, she turned to quilting to occupy her time, piecing together a variety of hand-made works of art. She was also a crochet and knitting enthusiast and had countless afghans to show for it - no doubt adorning the sofas and beds of various family members. She naturally enjoyed gardening, and had numerous exotic plants growing in pots all over the house.

In 1988, Elinor moved to the Dallas area to be closer to her children and grandchildren. She continued her hobbies, and became an active member of the Iris and Rose Society of Dallas, and the quilting club. She made many friends through these associations.

Elinor got a late start in her formal botanical education. She was over 50 when she entered graduate studies at ASU, but probably always had an interest in plants. As an undergraduate, she took a class from Dr. Norman Russel which apparently sparked her enthusiasm. Elinor's master's thesis was a floristic study of Lake Pleasant Regional Park, supervised by Dr. Donald Pinkava, Dr. Duncan Patten and Dr. Mont Cazier. She was interested in expanding our knowledge of the Upper Sonoran Desert flora and providing data for future comparisons. She also included a checklist of common lichens in the Park. She identified 364 vascular plant species (two new for Arizona) with added discussion on geology, climate, and vegetation of various habitat types and exposures – standard fare for a floristic study. But basic contributions to our knowledge of the flora of Arizona at the time were much

needed, and most importantly, provided frameworks for future botanical, ecological, and environmental studies.

Elinor's contributions to the ASU Herbarium were monumental. A simple search on SEINet [http://seinet.asu.edu/seinet/collections/index.jsp] brings up roughly 15,700 records in the four main regional herbaria with Lehto numbers. However, these records represent mostly Arizona taxa, so the total is much higher (probably around 25,000), as she collected all over the US and Mexico whenever she traveled.

One of her first tasks as Curator was apparently to begin assigning accession numbers to the collection. Beginning with the lower plants, as well as recording new accessions as they came, she hand wrote each taxon and number in journal entries. In 1962, there were approximately 11,500 sheets in the collection. By the time Elinor retired – 31 journals later, the collection had increased nearly 10-fold to over 112,000 specimens.

"Elinor absolutely loved to collect plants." says David Keil, a fellow grad student and self-described "herbarium groupie," currently Professor of Botany and Director of the Robert F. Hoover Herbarium at California Polytechnic State University San Luis Obispo. He first met Elinor in the spring of 1966 while taking Arizona Flora from Dr. Donald Pinkava. David recalls the "wow" moment when he was invited on a collecting trip to Lake Pleasant with Elinor and Don. That was the day he decided floristics was the career path for him.

Elinor was not an official teaching assistant for 'Arizona Flora', but went on field trips associated with the class – Usery Mountains, Mount Lemmon, Canyon Lake, etc. She was invaluable on those trips, as Dr. Pinkava was new to Arizona and unfamiliar with the flora at the time. Her knowledge of the Arizona flora was impressive and she seemed to know everything about the subject. Dr. Pinkava candidly admits to relying on Elinor a great deal in his first year teaching 'Flora.' Former students such as David Keil and Eric Sundell similarly credit Elinor for tutoring them in their first years at ASU.

In the early 1970's, Dr. Pinkava wrote a grant to travel and collect in Arizona. The purpose was to build the collection, especially in underrepresented areas of the state. The field trips often included the trio of Pinkava, Keil, and Lehto. Elinor was an enthusiastic, tireless field hand and "keeper of the notes." They would "collect by day, and bale by night," then get up and do it again the next day. They collected intensely in those first few years, and added thousands of important accessions, including range extensions, introduced species, and many new state records.

Keil looks back fondly on the countless hours they spent in the field and herbarium, sorting through exchange material playing "name that plant," and exchanging plant jargon across the room. The Herbarium Gang also periodically included Lyle McGill, Harry Tate, Tim Reeves, and others. Sometimes the green house manager and even janitor would gather for some herbarium banter and plant exploration.

Elinor had a knack for keying out plants. Many of the taxa she identified were yet to be represented in the Herbarium, but she was not shy about assigning an *Astragalus*, *Cryptantha*, or *Eriogonum* species name to a collection that had no

reference sheet. We all have our blunders, but Elinor, amazingly, got it right the vast majority of the time. She was intuitive, but also savvy with regional references to supplement Kearney and Peebles, 'Flora of Arizona'. Rarely can you thumb through a folder and not come across a Lehto specimen – one that she personally collected or annotated. Indeed, there have been several times when, after hours of searching and keying, and finally determining, you browse the cabinet for the taxon you are sure is new to the collection, only to find a thin folder containing a sheet with the familiar Lehto label. Sometimes you find that she collected the very same odd plant in the same place that you collected it years afterword.

Elinor dedicated nearly 20 years of her life collecting, identifying, and mounting plants for the ASU Herbarium. Her contributions have greatly increased its value to the botanical community and will continue to be appreciated in the future. But her untold hours assisting students, faculty, and visitors were equally important. Anyone associated with Elinor Lehto seems to recall similar fond memories - her knowledge and love of plants, willingness to always give a helping hand, and her loyal friendship.

Elinor Lehto, Arizona Botanist, 1915–2009. Elinor in the ASU Vascular Plant Herbarium (photo from the State Press, Oct. 13, 1965; courtesy of Don Pinkava)

New York Botanical Garden
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Index to Families of the Vascular Plants of Arizona

Bolded treatments are published in volumes 26, 27, 29, 30, 32, 33, and 35 of the *Journal of the Arizona-Nevada Academy of Science* (JANAS) or in subsequent volumes (e.g., 1–5) of CANOTIA. Unbolded entries indicate families with no treatments published to date. Figure numbers refer to illustrations in the "Key to Families of Vascular Plants in Arizona" in JANAS 35(2). Selected VPA treatments originally published in JANAS are also available as pdf files online (http://www.canotia.org/vpa_project.html).

Acanthaceae (Fig. 3)
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Adiantaceae (Fig. 1)
Agavaceae Part 1: *Agave* JANAS 32(1):1. 1999. (W. Hodgson)
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Alismataceae
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Aristolochiaceae JANAS 32(1):24. 1999. (C.T. Mason, Jr.)
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Betulaceae JANAS 33(1):1. 2001. (J.W. Brasher)
Bignoniaceae JANAS 32(1):26. 1999. (C.T. Mason, Jr.)
Bixaceae JANAS 27(2):188. 1994. (W. Hodgson)
Blechnaceae CANOTIA 4(2):35. 2008. (G. Yatskievych and M.D. Windham; Fig. 1)
Boraginaceae (Fig. 9)
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Bromeliaceae CANOTIA 3(2):23. 2007. (R. Gutierrez, Jr.)
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Burseraceae JANAS 32(1):29. 1999. (A. Salywon)
Cactaceae Part One: The Cereoid Cacti JANAS 29(1):6. 1995. (D.J. Pinkava)
Cactaceae Part Two: *Echinocactus* JANAS 29(1):13. 1995. (M. Chamberland)
Cactaceae Part Three: *Cylindropuntia* JANAS 32(1):32. 1999. (D.J. Pinkava)
Cactaceae Part Four: *Grusonia* JANAS 32(1):48. 1999. (D.J. Pinkava)
Cactaceae Part Five: *Pediocactus* and *Sclerocactus* JANAS 33(1):9. 2001. (K.D. Heil and J.M. Porter)
Cactaceae Part Six: *Opuntia* JANAS 35(2):137. 2003. (D.J. Pinkava).
Callitrichaceae JANAS 29(1):15. 1995. (J. Ricketson)
Campanulaceae
Cannabaceae JANAS 32(1):53. 1999. (C.T. Mason, Jr.)
Capparaceae (Fig. 8)
Caprifoliaceae (Fig. 10)
Caryophyllaceae (Fig. 10)
Celastraceae JANAS 30(2):57. 1998. (J.W. Brasher)
Ceratophyllaceae JANAS 29(1):17. 1995. (J. Ricketson)
Chenopodiaceae (Fig. 9)
Clusiaceae
Commelinaceae JANAS 33(1):19. 2001. (R. Puente and R. Faden)
Convolvulaceae JANAS 30(2):61. 1998. (D.F. Austin)
Cornaceae
Crassulaceae JANAS 27(2):190. 1994. (R. Moran)
Crossosomataceae JANAS 26(1):7. 1992. (C. Mason)
Cucurbitaceae (Fig. 10)
Cupressaceae JANAS 27(2):195. 1994. (J. Bartel)
Cuscutaceae
Cyperaceae (Fig. 18)
Dennstaedtiaceae CANOTIA 4(2):38. 2008. (G. Yatskievych and M.D. Windham; Fig. 1)
Dipsaceae JANAS 27(2):201. 1994. (J.E. LaFerriere)
Dryopteridaceae (Fig. 1)
Elaeagnaceae
Elatinaceae
Ephedraceae (Fig. 2)
Ericaceae CANOTIA 4(2):21. 2008. (J.L. Anderson; Fig. 11)
Euphorbiaceae Part One: *Acalypha* and *Cnidoscolus* JANAS 29(1):18. 1995. (G.A. Levin)
Equisetaceae CANOTIA 4(2):41. 2008. (G. Yatskievych and M.D. Windham)
Fabaceae (Figs. 12–13)
Fagaceae JANAS 27(2):203. 1994. (L.R. Landrum)
Fouquieriaceae JANAS 32(1):55. 1999. (C.T. Mason, Jr.)
Fumariaceae JANAS 33(1):27. 2001. (S. Holiday and A. Perez)
Garryaceae JANAS 33(1):31. 2001. (R. Puente and T.F. Daniel)
Gentianaceae JANAS 30(2):84. 1998. (C.T. Mason, Jr.)
Geraniaceae (Fig. 14)
Grossulariaceae
Haloragaceae
Hippuridaceae JANAS 29(1):25. 1995. (J. Ricketson)
Hydrangeaceae
Hydrocharitaceae
Hydrophyllaceae (Fig. 14)
Iridaceae Part One: *Sisyrinchium* JANAS 27(2):215. 1994. (A.F. Cholewa and D.M. Henderson)
Iridaceae Part Two: *Iris* and *Nemastylis* JANAS 33(1):35. 2001. (C.T. Mason, Jr.)
Isoëtaceae CANOTIA 5(1):27. 2009. (G. Yatskievych and M.D. Windham)
Juglandaceae JANAS 27(2):219. 1994. (J.E. LaFerriere)
Juncaceae (Fig. 19)
Juncaginaceae
Key to Families of Vascular Plants in Arizona JANAS 35(2):88. 2003. (D.J. Keil)
Krameriaceae JANAS 32(1):57. 1999. (B.B. Simpson and A. Salywon)
Lamiaceae Part One: *Agastache, Hyptis, Lamium, Leonurus, Marrubium, Monarda, Monardella, Nepeta, Salazaria, Stachys, Teucrium, and Trichostema* JANAS 35(2):151. 2003. (C.M. Christy, D.Z. Damrel, A. Henry, A. Trauth-Nare, R. Puente-Martinez, and G. Walters)
Lemnaceae JANAS 26(1):10. 1992. (E. Landolt)
Lennoaceae JANAS 27(2):220. 1994. (G. Yatskievych)
Lentibulariaceae
Liliaceae (Fig. 19)
Linaceae
Loasaceae JANAS 30(2):96. 1998. (C.M. Christy)
Lythraceae
Malpighiaceae
Malvaceae Part One: All genera except *Sphaeralcea*. JANAS 27(2):222. 1994. (P.A. Fryxell)
Marsileaceae CANOTIA 5(1):30. 2009. (G. Yatskievych and M.D. Windham)
Martyniaceae CANOTIA 3(2):26. 2007. (R. Gutierrez, Jr.)
Meliaceae
Menispermaceae JANAS 27(2):237. 1994. (J.E. LaFerriere)

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Menyanthaceae JANAS 33(1):38. 2001. (C.T. Mason, Jr.)
Monotropaceae JANAS 26(1):15. 1992. (E. Haber)
Molluginaceae JANAS 30(2):112. 1998. (C.M. Christy)
Moraceae
Najadaceae
Nyctaginaceae (Fig. 14)
Nymphaeaceae JANAS 29(1):26. 1995. (J. Ricketson)
Oleaceae (Fig. 15)
Onagraceae (Fig. 15)
Ophioglossaceae
Orchidaceae
Orobanchaceae
Oxalidaceae JANAS 30(2):115. 1998. (R. Ornduff and M. Denton)
Papaveraceae JANAS 30(2):120. 1998. (G.B. Ownbey with contributions by J.W. Brasher and C. Clark)
Passifloraceae JANAS 33(1):41. 2001. (J.M. MacDougal)
Phytolaccaceae JANAS 33(1):46. 2001. (V. Steinmann)
Pinaceae
Plantaginaceae JANAS 32(1):62. 1999. (K.D. Huisinga and T.J. Ayers)
Platanaceae JANAS 27(2):238. 1994. (J.E. LaFerriere)
Plumbaginaceae
Poaceae (Fig. 20)
Polemoniaceae CANOTIA 1(1):1. 2005. (D. Wilken and M. Porter)
Polygalaceae
Polygonaceae (Fig. 15)
Polypodiaceae CANOTIA 5(1):34. 2009. (G. Yatskievych and M.D. Windham; Fig. 1)
Pontederiaceae JANAS 30(2):133. 1998. (C.N. Horn)
Portulacaceae CANOTIA 2(1):1. 2006. (A. Bair, M. Howe, D. Roth, R. Taylor, T. Ayers, and R.W. Kiger)
Potamogetonaceae
Primulaceae JANAS 26(1):17. 1992. (A.F. Cholewa; Fig. 16)
Psilotaceae CANOTIA 3(2):32. 2007. (R. Gutierrez, Jr.)
Pyrolaceae JANAS 26(1):22. 1992. (E. Haber)
Rafflesiaceae JANAS 27(2):239. 1994. (G. Yatskievych)
Ranunculaceae (Fig.15)
Resedaceae
Rhamnaceae CANOTIA 2(1):23. 2006. (K. Christie, M. Currie, L. Smith Davis, M-E. Hill, S. Neal, and T. Ayers)
Rosaceae Part One: *Rubus*. JANAS 33(1):50. 2001. (J.W. Brasher)
Rubiaceae JANAS 29(1):29. 1995. (L. Dempster and E.T. Terrell; Fig. 16)
Ruppiaceae
Rutaceae
Salicaceae Part One: *Populus*. JANAS 26(1):29. 1992. (J.E. Eckenwalder)
Salicaceae Part Two. *Salix*. JANAS 29(1):39. 1995. (G.W. Argus)
Salviniaceae CANOTIA 4(2):50. 2008. (G. Yatskievych and M.D. Windham)
Santalaceae JANAS 27(2):240. 1994. (J.E. LaFerriere)
Sapindaceae JANAS 32(1):76. 1999. (A. Salywon)
Sapotaceae JANAS 26(1):34. 1992. (L.R. Landrum)
Saururaceae JANAS 32(1):83. 1999. (C.T. Mason, Jr.)
Saxifragaceae JANAS 26(1):36. 1992. (P. Elvander; Fig. 16)
Scrophulariaceae (Fig. 17)
Selaginellaceae CANOTIA 5(1):39. 2009. (G. Yatskievych and M.D. Windham)
Simaroubaceae JANAS 32(1):85. 1999. (J.W. Brasher)
Simmondsiaceae JANAS 29(1):63. 1995. (J. Rebman)
Solanaceae Part One: *Datura*. JANAS 33(1):58. 2001. (R. Bye)
Solanaceae Part Two: Key to the genera and *Solanum*. CANOTIA 5(1):1. 2009. (S.T. Bates, F. Farruggia, E. Gilbert, R. Gutierrez, D. Jenke, E. Makings, E. Manton, D. Newton, and L.R. Landrum)
Solanaceae Part Three: *Lycium*. CANOTIA 5(1):17. 2009. (F. Chiang and L.R. Landrum)
Sparganiaceae JANAS 33(1):65. 2001. (J. Ricketson)
Sterculiaceae
Tamaricaceae
Thelypteridaceae CANOTIA 5(1):49. 2009. (G. Yatskievych and M.D. Windham)
Tiliaceae
Typhaceae JANAS 33(1):69. 2001. (J. Ricketson)
Ulmaceae JANAS 35(2):170. 2003. (J.W. Brasher)
Urticaceae JANAS 26(1):42. 1992. (D. Boufford)
Valerianaceae
Verbenaceae
Violaceae. JANAS 33(1):73. 2001. (R.J. Little; Fig. 17)
Viscaceae JANAS 27(2):241. 1994. (F.G. Hawksworth and D. Wiens)
Vitaceae
Zannichelliaceae
Zygophyllaceae (Fig. 17)